

Information Analysis Center Contributions to

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DoD S&T THRUSTS
Volume I of IV

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Preface

The Department of Defense has established the DoD Information Analysis Centers (IAC) program as part of the DoD Scientific and Technical Information Program. IACs exist to assist users in making best use or application of existing scientific, technical and related information. In so doing, the 23 chartered DoD IACs and the Service or Component sponsored information centers save scarce DoD scientific and technical resources, prevent unnecessary duplication of effort among DoD components, and provide additional technical assistance to DoD components, other U.S. Government agencies and departments, their contractors, and other qualified users. The table on the following pages lists the Information Centers and the Point of Contact for each one.

This volume summarizes in unclassified unlimited distribution format, work performed by DoD Information Analysis Centers for DoD or other U.S. Government sponsors which has application over and beyond the immediate requirement to which the IACs responded. Readers are advised that much of the specific work, the resulting data, and interim or final reports described herein may be classified or otherwise withheld from general distribution in accordance with appropriate statute and/or DoD regulations. On balance, however, it is appropriate that DoD IACs share with their broadest user communities the results of data and information collection efforts, efforts to maintain and develop analytical tools and techniques, and the results of detailed studies and analyses of scientific, technical and related problems. These results are often applicable to problems which extend beyond the narrow focus of DoD, and can be described in terms that compromise no classified or sensitive information.

The DoD IAC Program has access to DoD's investment in science and technology spanning the past 40 years. It has access to the analytical tools and techniques which DoD has used to assess this information. The scientific and technical challenges facing the nation go well beyond the boundaries of the DoD IAC Program; the efforts of DoD IACs described at least in part in this volume illustrate the potential contributions IACS could make. Potential users, inside or outside the executive branch of the U.S. Government are encouraged to contact IACs of interest or the DoD IAC Program Management Office to obtain additional assistance or to make use of the knowledge and skills resident within this program.

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INFORMATION CENTERS

DoD Information Analysis Centers		
APMIAC	Airfields, Pavements and Mobility Information Analysis Center	Mr. Gerald Turnage Phone: (601) 634-2734
CBIAC	Chemical Warfare/Chemical and Biological Defense Information Analysis Center	Mr. James J. McNeely Phone: (410) 676-9030 E-Mail: jjmcneel@im.battelle.org
CEIAC	Coastal Engineering Information Analysis Center	Dr. Fred Camfield Phone: (601) 634-2012 E-Mail: camfield@coafs1.wes.army.mil
CIAC	Ceramics Information Analysis Center	Dr. C. Y. Ho Phone: (317) 494-9393 Dr. Said K. El-Rahaiby Phone: (317) 494-9393 E-Mail: rahaiby@ecn.purdue.edu
CPIA	Chemical Propulsion Information Agency	Mr. Thomas W. Christian Phone: (410) 992-7300 E-Mail: cpia1_tc@jhunix.hcs.jhu.edu
CRSTIAC	Cold Regions Science and Technology Information Analysis Center	Ms. Nancy Liston Phone: (603) 646-4221 E-Mail: nliston@hanover-crrtel.army.mil
CSERIAC	Crew System Ergonomics Information Analysis Center	Dr. Lawrence D. Howell Phone: (513) 255-4842 E-Mail: lhowell@falcon.aamrl.wpafb.af.mil
CTIAC	Concrete Technology Information Analysis Center	Phone: (601) 634-3264

DoD Information Analysis Centers (Continued)

DACS	Data and Analysis Center for Software	Mr. Dennis J. Wesolowski Phone: (315) 734-3696 E-Mail: dennisw@kaman.com
DASIAC	DoD Nuclear Information and Analysis Center	Phone: (703) 329-7123 E-Mail: claire-watson@bob.kaman.com
GACIAC	Guidance and Control Information Analysis Center	Dr. Robert J. Heaston Phone: (312) 567-4519 E-Mail: rheaston@dgis.dtic.dla.mil
HEIAC	Hydraulic Engineering Information Analysis Center	Phone: (601) 634-2608
HTMIAC	High Temperature Materials Information Analysis Center	Dr. C. Y. Ho (317) 494-9393 Dr. Ronald H. Bogaard Phone: (317) 494-9393 E-Mail: bogaard@ecn.purdue.edu
IRIA	Infrared Information Analysis Center	Dr. Rodney C. Anderson Phone: (313) 994-1200, Ext. 2725 E-Mail: anderson@erim.org
MIAC	Metals Information Analysis Center	Dr. C. Y. Ho Phone: (317) 494-9393 Dr. Pramod D. Desai Phone: (317) 494-9393 E-Mail: desaip@ecn.purdue.edu
MMCIAC	Metal Matrix Composites Information Analysis Center	Dr. C. Y. Ho Phone: (317) 494-9393 E-Mail: hocy@ecn.purdue.edu Dr. Harvey M. Berkowitz Phone: (317) 494-9393

DoD Information Analysis Centers (Continued)

MTIAC	Manufacturing Technology Information Analysis Center	Ms. Michal Safar Phone: (312) 567-4733 E-Mail: msafar@dgis.dtic.dla.mil
NTIAC	Nondestructive Testing Information Analysis Center	Dr. George A. Matzkanin Phone: (512) 263-2106 E-Mail: ntiac@access.texas.gov
PLASTEAC	Plastics Technical Evaluation Center	Mr. Charles Yearwood Phone: (201) 724-4222 E-Mail: yearwood@pica.army.mil
RAC	Reliability Analysis Center	Mr. Preston MacDiarmid Phone: (315) 337-0900 E-Mail: rac@mail.itri.com
SMIAC	Soil Mechanics Information and Analysis Center	Mr. David R. Haulman Phone: (601) 634-3376
SURVIAC	Survivability/Vulnerability Information Analysis Center	Mr. John Vice Phone: (513) 255-4840 E-Mail: vice@isi.edu
TWSTIAC	Tactical Warfare Simulation and Technology Information Analysis Center	Dr. Larry W. Williams Phone: (614) 424-5047 E-Mail: williaml@battelle.org Mr. Ernie Smart (Distributed Interactive Simulation) Phone: (407) 658-5014 E-Mail: esmart@dmso.dtic.dla.mil

Service Sponsored Information Centers		
SAVIAC	Shock and Vibration Information Analysis Center	Mr. Hal Kohn Phone: (703) 412-7856 E-Mail: kohn@ccity.ads.com
ASIAC	Aerospace Structures Information and Analysis Center	Mr. Gordon Negaard Phone: (513) 255-6688 E-Mail: asiac@sltvc1.flight.wpafb.af.mil
SIDAC	Supportability Investment Decision Analysis Center	Mr. Kevin Deal Phone: (513) 258-6711 E-Mail: kdeal@bcic11

Foreword to Volume I

The Department of Defense adopted a new acquisition strategy in the early 1990s. This strategy seeks to preserve the defense-related technology base while deferring decisions with regard to the acquisition of specific military systems until detailed threats, roles, missions, and functions requiring new technology have been identified. As part of this strategy, DoD has described seven specific areas of science and technology in which a series of technology investments culminating in Advanced Technology Demonstration Projects will be undertaken. These areas, known as DoD Science and Technology Thrusts, include the following:

- Global Surveillance & Communications
- Precision Strike
- Air Superiority and Defense
- Sea Control and Undersea Superiority
- Advanced Land Combat
- Synthetic Environments
- Technology for Affordability

The DoD Information Analysis Center (IAC) Program oversees 23 IACs and sponsors 15 contractor operated IACs. Each of the DoD acquisition endeavors listed above is the focus of information collection, synthesis, analysis or analytical tool maintenance or development activities by one or more DoD IAC.

This volume describes work completed by DoD IACs over the past 24 months relevant to DoD Science and Technology Thrusts. As noted in the Preface, much of the work completed is not generally available outside the Department of Defense or the U.S. Government. The raw data, the reduced data, and the analytical techniques used to collect or assess such information may be available. Interested readers are encouraged to contact the IAC reporting results of interest and/or the DoD IAC Program Management Office for additional information.

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Volume I of IV			Presented by: Dr. Forrest R. Frank
The DoD Information Analysis Center (IAC) Program			
DoD S&T Thrusts			
(Each thrust is in a separate section. Each section begins with a blue divider page.)			
Thrust	IAC	Presentation	
Global Surveillance & Communications	GACIAC	Strategic Forces and Missions	
	HTMIAC	Inquiry Response Related to Global Surveillance	
	IRIA	Air Superiority and Global Surveillance: Shipboard Infrared Search and Track Sensors	
	TWSTIAC	Assessment of Ultra-Wideband (UWB) Radar Technology	
	CRSTIAC	Observations of Acoustic Surface Waves Propagating Above a Snow Cover	
Precision Strike	CRSTIAC	Smart Weapons Operability Enhancement (SWOE) Program	
	GACIAC	Precision Strike	
	GACIAC	Sensors and Electronic Devices	
	IRIA	Sensors and Electronic Devices: Multispectral Detection	
	TWSTIAC	Generic Sensor Package S&T Assessment for the Office of Naval Research	
	TWSTIAC	Assessment of Ultra-Wideband (UWB) Radar Technology	

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DoD S&T Thrusts		
(Each thrust is in a separate section. Each section begins with a blue divider page.)		
Thrust	IAC	Presentation
Air Superiority and Defense	CPIA	Literature Searches: A Series of CPIA Core Products Directed to the DoD Thrust on Air Superiority
	IRIA	Air Superiority and Global Surveillance: Shipboard Infrared Search and Track Sensors
	SURVIAC	The Joint Live Fire/Live Fire Test (JLE/LFT) Program Catalogue
	SURVIAC	U.S. Air Force Surface-to-Air Engagements During Operation Desert Storm
	TWSTIAC	Analysis of Effects of New Weapons Systems in the Employment of Tactical Air Forces
	TWSTIAC	Assessment of Ultra-Wideband (UWB) Radar Technology
	CBIAC	Evaluation of Feasibility of a Biological Agent Detection Concept
Sea Control and Undersea Superiority	CBIAC	Interactive Decision Training Scenario for USN Damage Control and CBR-D Decision Training
	CRSTIAC	Ship Superstructure Icing
	TWSTIAC	Mission Analysis of Future Enhanced Survivability Ship Platforms

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DoD S&T Thrusts		
(Each thrust is in a separate section. Each section begins with a blue divider page.)		
Thrust	IAC	Presentation
Advanced Land Combat	CBIAC	Bio Technology: A Survey of Seven Technologies to Identify Clostridium Botulinum and Bacillus Anthracis
	CBIAC	Evaluation of Lightweight Integrated Suit Technologies (LIST) and Associated Test Methods
	GACIAC	Advanced Land Combat
	GACIAC	Tactical Land Forces
	NTIAC	Nondestructive Evaluation Applications for Strategic Forces and Missions
	NTIAC	Nondestructive Test/Evaluation Assessment in Support of Tactical Land Forces and Missions
	SURVIAC	The Joint Live Fire/Live Fire Test (JLFF/LFT) Program Catalogue
	SURVIAC	Survivability Systems Master Plan
	TWSTIAC	A Notional Individual Fighting System
	TWSTIAC	Evaluation of Candidate Warheads Against Chemical Targets for Patriot PAC-3
	TWSTIAC	TWSTIAC Casualty Reduction Modeling for the Natick R&D Center

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Dead S&T Thrusts		
(Each thrust is in a separate section. Each section begins with a blue divider page.)		
Thrust	IAC	Presentation
Synthetic Environments	CBIAC	Chemical Warfare Counter Proliferation Computerized Decision Aid
	CRSTIAC	Decision and Analysis of a Low Speed Drag Flow for Deep Snow
	CRSTIAC	Observations of Acoustic Surface Waves Propagating Above a Snow Cover
	CRSTIAC	Ship Superstructure Icing
	CRSTIAC	Smart Weapons Operability Enhancement (SWOE) Program
	CSERIAC	Crew System Ergonomics Information Analysis Center (CSERIAC) Products & Services -- Human Factors in the Design of Synthetic Environments
	TWSTIAC	TWSTIAC Casualty Reduction Modeling for the Natick RD&E Center
	TWSTIAC	Computers & Software Communications Networking
	TWSTIAC	Synthetic Environment

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DoD S&T Thrusts		
(Each thrust is in a separate section. Each section begins with a blue divider page.)		
Thrust	IAC	Presentation
Technology for Affordability	CEIAC	Chemical Warfare Counter Proliferation Computerized Decision Aid
	CSERIAC	Crew System Ergonomics Information Analysis Center (CSERIAC) Products & Services -- Integrated Maintenance Information System (IMIS): Defined
	DACS	DACS Technical Reports
	DACS	Open Architecture Systems for Process Automation (OASYS)
	MTIAC	MTIAC Directory of Manufacturing Research Centers
	MTIAC	Army Strategic ManTech Plan Workshop and Minutes
	MTIAC	Rapid Prototyping MTIAC State-of-the-Art-Report
	NTIAC	Nondestructive/Non-Intrusive Sensors for Manufacturing Process Control
	RAC	Concurrent Engineering Series
	RAC	Total Quality Management (TQM) Toolkit
	SURVIAC	Computer-Based Aircraft Wiring Maintenance Aid

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The DoD Information Analysis Center (IAC) Program		Presented by: Dr. Forrest R. Frank
DoD Key Technologies		
Each Technology is in a separate section. Each section begins with a blue divider page.		
Technology	IAC	Presentation
Computers	CBIAC	MEDTAG Concept Evaluation and Prototype Development Plan
	CSERIAC	Crew System Ergonomics Information Analysis Center (CSERIAC) Products & Services -- Computer-Aided Systems Human Engineering (CASHE)
	DACS	DACS Technical Reports
	DACS	Open Architecture Systems For Process Automation (OASYS)
	TWSTIAC	TWSTIAC Support to Development of a Networked CD-ROM Database
	TWSTIAC	Computers & Software Communications Networking
Software	CSERIAC	Crew System Ergonomics Information Analysis Center (CSERIAC) Products & Services -- Advanced Human System Interface Design in Control Rooms
	CSERIAC	Crew System Ergonomics Information Analysis Center (CSERIAC) Products & Services -- Human Factors in the Design of Synthetic Environments

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Software (Continued)	DACS	DACS Technical Reports
	DACS	Open Architecture Systems for Process Automation (OASYS)
Sensors	CBIAC	Bio Technology: A Survey of Seven Technologies to Identify Clostridium Botulinum and Bacillus Anthracis
	GACIAC	Sensors and Electronic Devices
	IRIA	Sensors and Electronic Devices: Multispectral Detection
	IRIA	Strategic Forces and Arms Control: Infrared Signature Computer Codes
	IRIA	Sensors and Electronic Devices: Infrared and Electro-Optical Systems Handbook
	IRIA	Sensors and Electronic Devices: Infrared Data Bases
	RAC	Reliable Application of Components Series
	TWSTIAC	Generic Sensor Package S&T Assessment for the Office of Naval Research
	TWSTIAC	Assessment of Ultra-Wideband (UWB) Radar Technology

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Communications Networking	TWSTIAC	TWSTIAC Support to Development of a Networked CD-ROM Database
	TWSTIAC	Computers & Software Communications Networking
Electronic Devices	GACIAC	Sensors and Electronic Devices
	IRIA	Sensors and Electronic Devices: Multispectral Detection
	RAC	Failure Mode/Mechanism Distributions
	RAC	Time Stress Measurement Device (TSMD)
Environmental Effects	CBIAC	Bio Technology: A Survey of Seven Technologies to Identify Clostridium Botulinum and Bacillus Anthracis
	CRSTIAC	Design and Analysis of a Low Speed Drag Plow for Deep Snow
	CRSTIAC	Observations of Acoustic Surface Waves Propagating Above a Snow Cover
	CRSTIAC	Ship Superstructure Icing
	CRSTIAC	Smart Weapons Operability Enhancement (SWOE) Program
	CRSTIAC	Waterfowl Mortality in Eagle River Flats, Alaska

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Environmental Effects (Continued)	HEIAC	Dam Break Analyses
Materials and Processes	APMIAC	Facilities Engineering Applications Program (FEAP)
	CIAC	Advanced Materials and Processing Technology Workshop and Proceedings
	CIAC	Assessment of the Status of Ceramic Matrix Composites Technology in the United States and Abroad
	HTMIAC	High Temperature Materials Properties Online Numeric Database Capability for Dual-Use Technology Transfer
	HTMIAC	Database on Laser-Induced Damage Threshold for Strategic Forces and Missions
	MIAC	Computerization of Properties of Austempered Ductile Iron (ADI)
	MIAC	Corrosion in DoD Systems: Data Collection and Analysis
	MMCIAC	Engineered Materials Briefing at the Capital Metals and Materials Forum
	MMCIAC	Bibliographies Prepared for Various DoD Small Business Innovative Research (SBIR) Program Solicitation Topics

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Materials and Processes (Continued)	MMCIAC	Silicon-Carbide/Magnesium Composites Bibliography
	NTIAC	Critical DoD Advanced Materials: Scientific and Technical Information Analysis
	NTIAC	Quantitative Nondestructive Evaluation (NDE) Data Book
Energy Storage	CPIA	Rocket Motor Manual: One of CPIA's Standard Manuals Directed to the Key DoD Technology on Energy Storage
Propulsion and Energy Conversion	CPIA	Explosive Ingredients Sources Database (EISD): A CPIA Technical Area Task Applied to Naval Surface Sea Control
	CPIA	Chemical Propulsion Technology Reviews: A Series of CPIA Core Products Directed to the Key DoD Technology on Propulsion and Energy Conversion
	CSERIAC	Crew System Ergonomics Information Analysis Center (CSERIAC) Products & Services -- Advanced Human System Interface Design in Control Rooms
Design Automation	CSERIAC	Crew System Ergonomics Information Analysis Center (CSERIAC) Products & Services -- Computer-Aided Systems Human Engineering (CASHE)
	MTIAC	Rapid Prototyping MTIAC State-of-the-Art-Report

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Human System Interfaces	CBIAC	Evaluation of Lightweight Integrated Suit Technologies (LIST) and Associated Test Methods
	CBIAC	Interactive Decision Training Scenario for USN Damage Control and CBR-D Decision Training
	CBIAC	MEDTAG Concept Evaluation and Prototype Development Plan
	CSERIAC	Crew System Ergonomics Information Analysis Center (CSERIAC) Products & Services -- Advanced Human System Interface Design in Control Rooms
	CSERIAC	Crew System Ergonomics Information Analysis Center (CSERIAC) Products & Services -- Human Factors Issue in Personnel Training: Potpourri
	CSERIAC	Crew System Ergonomics Information Analysis Center (CSERIAC) Products & Services -- Human Factors in the Design of Synthetic Environments
	CSERIAC	Crew System Ergonomics Information Analysis Center (CSERIAC) Products & Services --State-of-the-Art Human Factors Technical Information

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Strategic Nuclear Forces	HTMIAC	Database on Laser-Induced Damage Threshold for Strategic Forces and Missions
	IRIA	Strategic Forces and Arms Control: Infrared Signature Computer Codes
	TWSTIAC	Assessment of Ultra-Wideband (UWB) Radar Technology
	CBIAC	Interactive Decision Training Scenario for USN Damage Control and CBR-D Decision Training
Tactical Air Forces	CRSTIAC	Smart Weapons Operability Enhancement (SWOE) Program
	GACIAC	Precision Strike
	RAC	Service Life Extension Assessment
	SURVIAC	U.S. Air Force Surface-to-Air Engagements During Operation Desert Storm

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Tactical Air Forces (Continued)	TWSTIAC	Analysis of Effects of New Weapons Systems in the Employment of Tactical Air Forces
Naval Forces	CRSTIAC	Ship Superstructure Icing
	MIAC	Failure Analysis on Electroslag Remelt (ESR) 4340 Steel
	RAC	Service Life Extension Assessment
	TWSTIAC	Generic Sensor Package S&T Assessment for the Office of Naval Research
Ground Combat Forces	TWSTIAC	Mission Analysis of Future Enhanced Survivability Ship Platforms
	CBIAC	Evaluation of Lightweight Integrated Suit Technologies (LIST) and Associated Test Methods
	CBIAC	MEDTAG Concept Evaluation and Prototype Development Plan
	CRSTIAC	Design and Analysis of a Low Speed Drag Flow for Deep Snow
	CRSTIAC	Smart Weapons Operability Enhancement (SWOE) Program

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Logistics	CBIAC	Evaluation of Lightweight Integrated Suit Technologies (LIST) and Associated Test Methods
	CSERIAC	Crew System Ergonomics Information Analysis Center (CSERIAC) Products & Services -- Advanced Human System Interface Design in Control Rooms
	CSERIAC	Crew System Ergonomics Information Analysis Center (CSERIAC) Products & Services -- Integrated Maintenance Information System (IMIS): Defined
	CSERIAC	Crew System Ergonomics Information Analysis Center (CSERIAC) Products & Services -- Human Factors in the Design of Synthetic Environments
	DACS	Open Architecture Systems for Process Automation (OASYS)
	MTIAC	Academic Apparel Research Technical Support and Products for DLA
	NTIAC	Quantitative Nondestructive Evaluation (NDE) Data Book

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	RAC	Failure Mode/Mechanism Distributions
	RAC	Time Stress Measurement Device (TSMMD)
	RAC	Total Quality Management (TQM) Toolkit
	SURVIAC	Computer-Based Aircraft Wiring Maintenance Aid
Training	CBIAC	Interactive Decision Training Scenario for USN Damage Control and CBR-D Decision Training
	CRSTIAC	Waterfowl Mortality in Eagle River Flats, Alaska
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	CSERIAC	Crew System Ergonomics Information Analysis Center (CSERIAC) Products & Services -- Human Factors Issue in Personnel Training: Potpourri
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Training (Continued)	TWSTIAC	Computers & Software Communications Networking
Arms Control	CBIAC	Bio Technology: A Survey of Seven Technologies to Identify Clostridium Botulinum and Bacillus Anthracis
	CBIAC	Chemical Warfare Counter Proliferation Computerized Decision Aid
	CBIAC	Commercial Products From Demilitarization Operations
	IRIA	Strategic Forces and Arms Control: Infrared Signature Computer Codes
	IRIA	Strategic Forces and Arms Control: "Open Skies" Support
Dual Use	CBIAC	Bio Technology: A Survey of Seven Technologies to Identify Clostridium Botulinum and Bacillus Anthracis
	CBIAC	Chemical Warfare Counter Proliferation Computerized Decision Aid
	CBIAC	Commercial Products From Demilitarization Operations
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	CSERAC	Crew System Ergonomics Information Analysis Center (CSERIAC) Products & Services -- Integrated Maintenance Information system (IMIS): Defined
	DACS	DACS Technical Reports
	DACS	Open Architecture Systems for Process Automation (OASYS)
	HEIAC	Dam Break Analyses
	HTMIAC	High Temperature Materials Properties Online Numeric Database Capability for Dual-Use Technology Transfer
	NTIAC	Nondestructive/Non-Intrusive Sensors for Manufacturing Process Control
	RAC	Concurrent Engineering Series

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This compilation is Limited Distribution, therefore, not all attendees will receive this volume.

Product Listings

This compilation lists products from the IACs in the following sequence: those that are relevant to the DoD S&T Thrusts, the Key Technologies, and Military Forces, Roles, Missions, and Functions. Each product is described in terms of: IAC Product Identification Number, Primary Author Name(s), Title, Publication Date, and Available From. Registered users can acquire documents having AD Numbers from the Defense Technical Information Center (DTIC). Please contact the particular IAC to determine the availability of documents which do not have AD Numbers.

CBIAC

CIAC

CPIA

CSERIAC

DACS

HEIAC

HTMIAC

IRIA

MIAC

MMCIAC

RAC

SURVIAC

TWSTIAC

DoD INFORMATION ANALYSIS CENTER (IAC) PROGRAM

DoD Information Analysis Center (IAC) Program



Presentation by:
Forrest R. Frank
Program Manager, DoD IAC Program

DTIC

Defense Technical Information Center • IAC Program

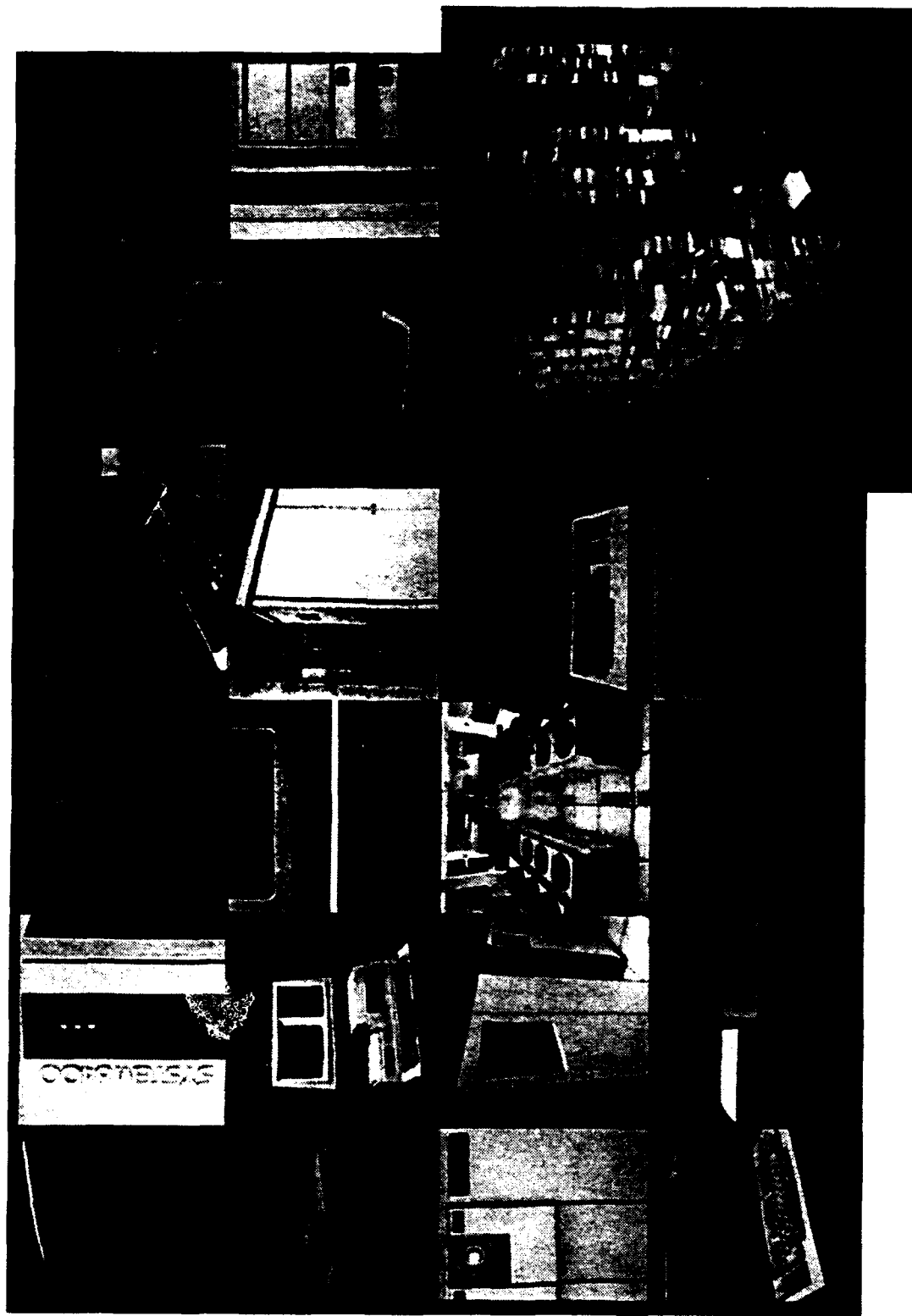
DoD Information Analysis Center (IAC) Program



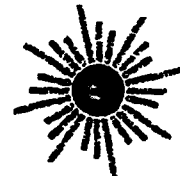
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Defense Technical Information Center • IAC Program

Extraneous Information



Information Overload



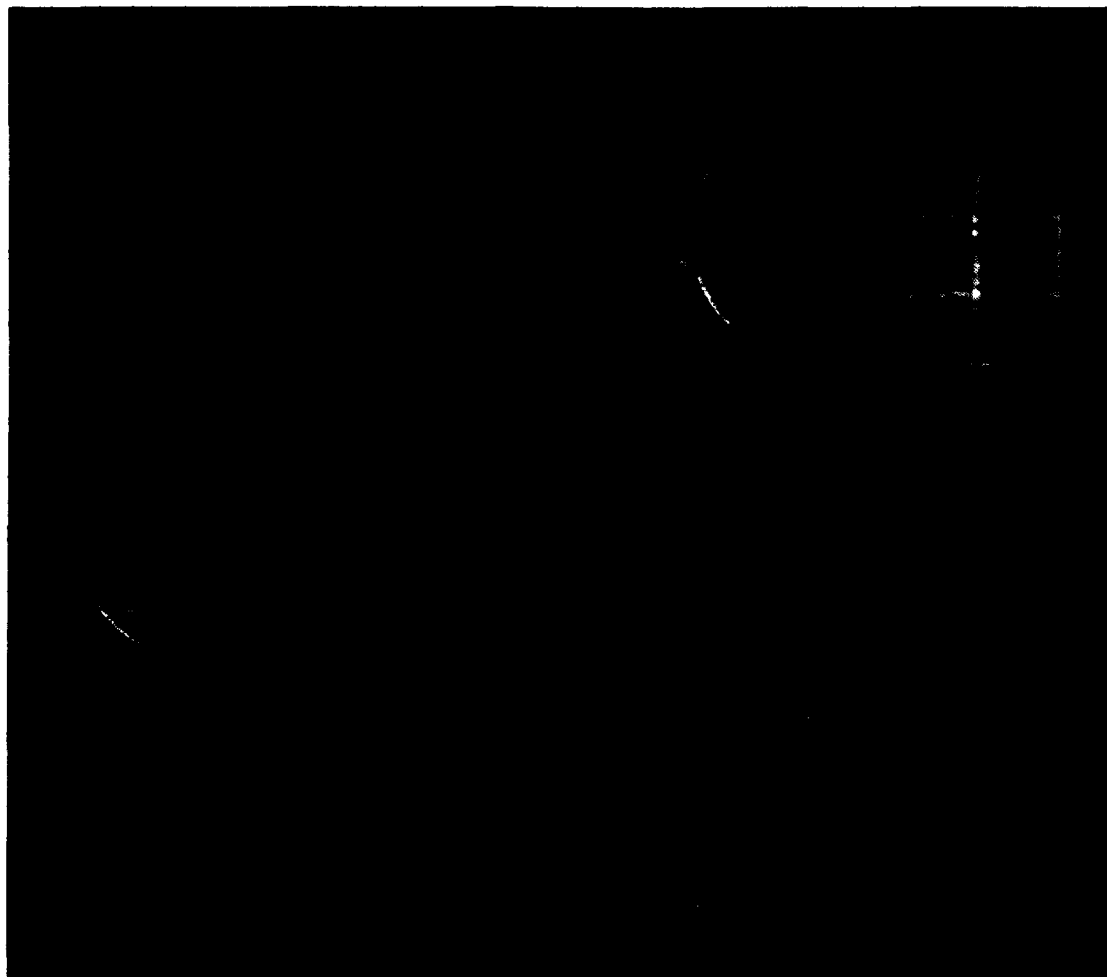
- **Identify Relevant Data**
- **Reduce Relevant Data to Information**
- **Identify and Employ Appropriate Analytical Tools and Techniques**



DTIC

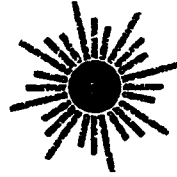
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Can It Be This Simple Again?



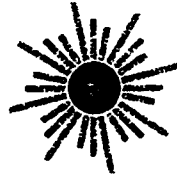
Briefing Overview

- **Mission of IACs**
- **Authority**
- **IAC Functions**
- **IAC Operations**
- **IAC Products and Services**
- **Subject-Matter Coverage**
- **Using DoD IACs**
- **Benefits of IACs**



Authority

- **Formal Organization Chartered by DoD
 - DoD Regulation 3200.12-R-2**
- **Staffed by Technical Experts**
- **Co-Located Laboratories and/or Other Technical Activities**
- **Collect and Disseminate Scientific and Technical Information**
- **Provide STINFO Support to DoD, Other U.S. Government Agencies, and Other Authorized Users**



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DoD Operates 23 IACs



DoD IACs - Some Examples

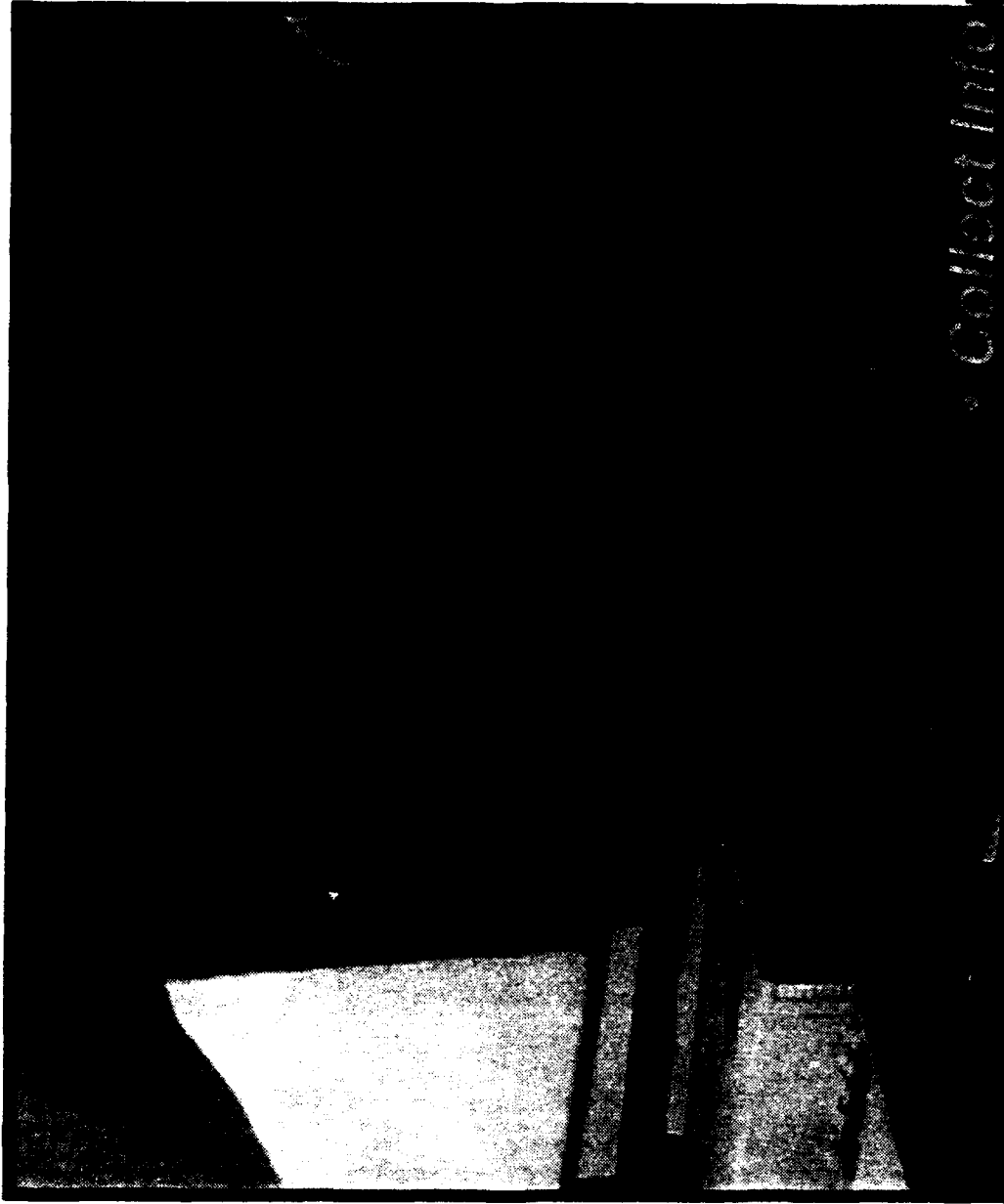
- **CSEIRIAC**
**Crew System Ergonomics
Information Analysis Center**
- **DACS**
**Data and Analysis Center for
Software**
- **MTIAC**
**Manufacturing Technology
Information Analysis Center**
- **NTIAC**
**Nondestructive Testing
Information Analysis Center**
- **SURVIAC**
**Survivability/Vulnerability
Information Analysis Center**



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Worldwide Information

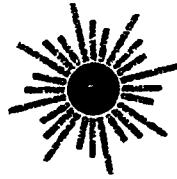


**Collect Information on
a Worldwide Basis**



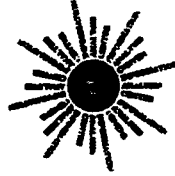
IAC Functions - User Perspective

- **Answer Questions**
 - Referrals
 - Bibliographic Inquiries
 - Techniques and Methods
 - Data Analysis
 - Current Awareness
- **Provide Advice**
 - Technical Advisory Services
 - Technical Transfer
 - Studies and Analyses
 - Symposia, Conferences, Workshops



IAC Operations

- **Information Collection**
 - **Discipline and/or Mission Focus**
 - **Domestic and International**
 - **All Media**
 - **Classified/Unclassified**
 - **Limited/Unlimited Distribution**
- **Information Storage and Retrieval**
- **Information Synthesis and Analysis**
 - **Analytical Tools and Techniques**
 - **Studies and Analyses**
- **Information Dissemination**



IAC Information Products and Services

- **IAC Products**
- **Reference Tools (Handbooks, Data Books, etc.)**
- **Models and Simulations**
- **Standards and Specifications**
- **Studies and Analyses**



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IAC Information Products and Services

- **Technical Information Services**
- **Referrals**
- **Bibliographic and Technical Inquiries**
- **Advice**
- **Program and Project Support (per CAAS Directive)**



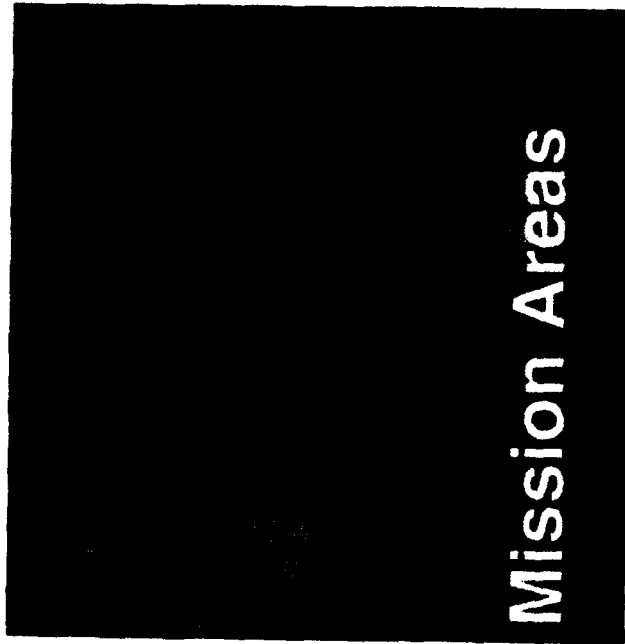
Subject-Matter Coverage



Three Taxonomies



- **Military Forces and Mission Areas**
- **Key Technologies**
- **Science and Technology Thrusts**



DoD Missions and Functional Areas

DoD Missions and Functional Areas Selected IACs	Nuclear Forces	Ground Forces	Naval Forces	Tactical Air Forces	SOF	Intelligence	Com- munications	Logistics	Training	Medical Support
GBIAC		✓	✓	✓	✓	✓	✓	✓	✓	✓
GIAC		✓	✓	✓	✓	✓	✓		✓	
CSERIAC		✓	✓	✓					✓	
GACIAC	✓	✓	✓	✓		✓			✓	
HTMIAC	✓	✓	✓	✓					✓	
MIAC	✓	✓	✓	✓					✓	
MMCIAC	✓	✓	✓	✓				✓		
MTIAC					✓	✓		✓	✓	✓
NTIAC		✓	✓	✓	✓	✓		✓	✓	✓
SURVIAC		✓	✓	✓	✓	✓		✓	✓	✓
TWSTIAC		✓	✓	✓	✓	✓		✓	✓	✓



IACs and Key Technologies

Technology Interest of Potential User Selected IACs	Computers	Software	Sensors	Communication Networking	Electronic Devices	Environmental Effects
CBIAC	✓		✓		✓	✓
CIAC			✓		✓	
CSERIAC	✓			✓	✓	
GACIAC		✓	✓		✓	✓
HTMIAC		✓	✓		✓	✓
MIAC						✓
MMCIAC						✓
MTIAC	✓	✓	✓	✓	✓	✓
NTIAC	✓		✓			
SURVIAC		✓	✓		✓	
TWSTIAC	✓	✓	✓	✓	✓	✓



IACs and Key Technologies

Technology Interest of Potential User Selected IACs	Materials and Processes	Energy Storage	Propulsion and Energy Conversion	Design Automation	Human System Interfaces
CBIAC					✓
CIAC	✓		✓		
CSERIAC				✓	✓
GACIAC	✓	✓	✓	✓	
HTMIAC	✓		✓		
MIAC	✓		✓		
MMCIAC	✓	✓	✓	✓	✓
MTIAC	✓				✓
NTIAC	✓				✓
SURVIAC	✓	✓	✓	✓	✓
TWSTIAC	✓	✓	✓	✓	✓



IACs and Science and Technology Thrusts

Science and Tech Thrust of User Selected IACs	Global Surveillance	Precision Strike	Air Superiority and Defense	Sea Control/Undersea Superiority	Advanced Land Combat	Synthetic Environments	Technology to Enhance Capability
CBIAC					✓		
CIAC	✓	✓	✓	✓	✓		
CSERIAC			✓	✓	✓	✓	✓
GACIAC	✓	✓	✓	✓	✓	✓	✓
HTMIAC		✓			✓		✓
MIAC			✓	✓	✓		
MMCIAC	✓		✓	✓	✓		✓
MTIAC							✓
NTIAC				✓	✓	✓	✓
SURVIAC		✓	✓	✓	✓	✓	
TWSTIAC		✓			✓	✓	



Using DoD IACs

- **Basic Services**
 - **Call, Write, Visit**
 - **Direct Contact with IAC**
 - **No or Minimal Charge**
- **Extended Basic Services**
 - **Direct Contact with IAC and COTR**
 - **Negotiated Fee for Service**
- **Technical Area Tasks (TATs)**
 - **Extensive Contact with IAC and COTR**
 - **Separate Funding and Contract Modification**
 - **Review and Approval by IAC Program Management Office (PMO)**



Who To Contact

Defense Technical Information Center

Attn: DTIC-AI

Cameron Station

Alexandria, VA 22304-6145

Phone: (703) 274-6260 or DSN 284-6260

Fax: (703) 274-0980 or DSN 284-0980

Electronic Mail: ffrank@dgis.dtic.dla.mil



IAC Benefits

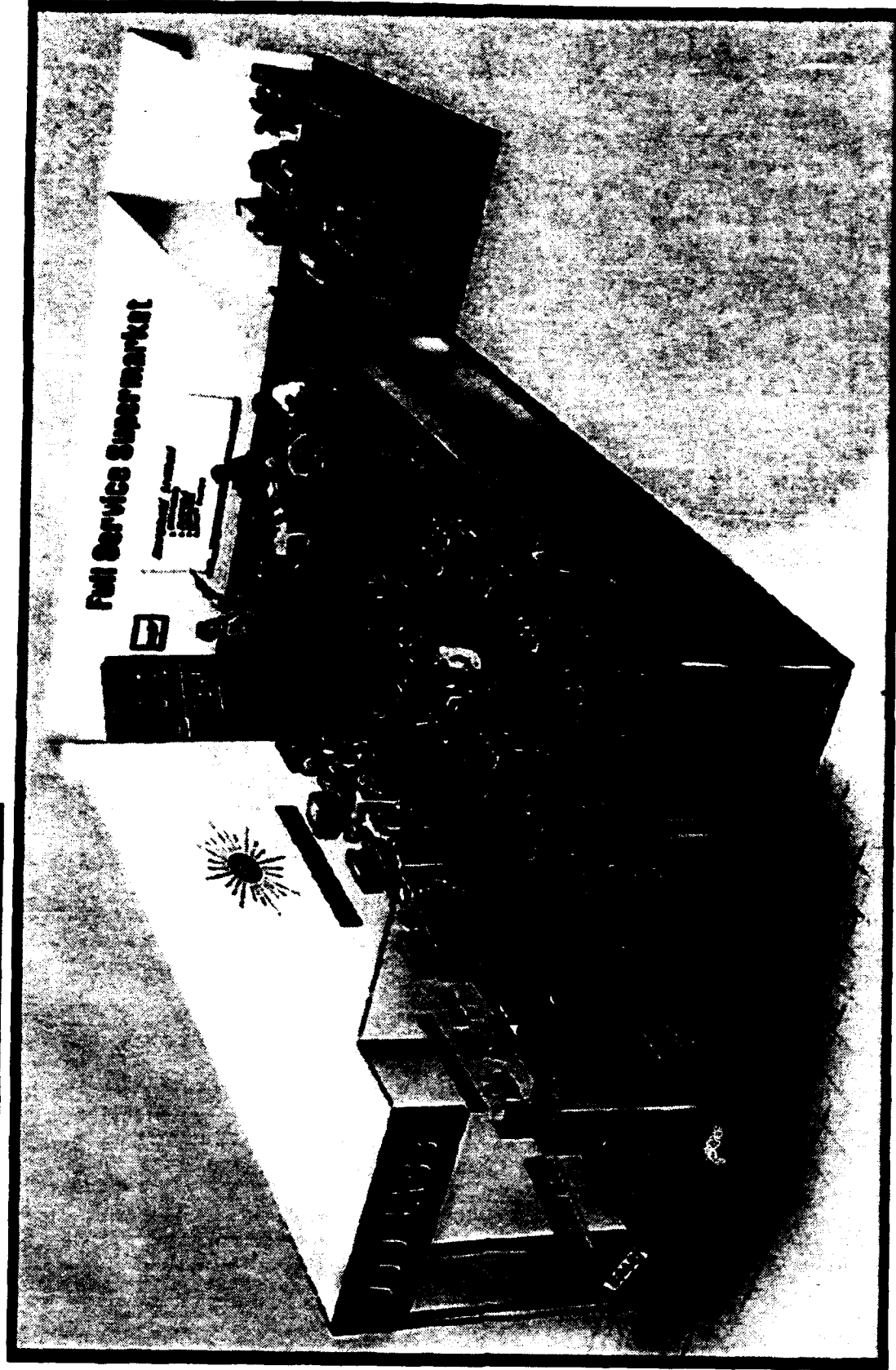
- **Quantitative Benefits**
 - **Value Engineering Analysis**
 - **Cost Avoidance**
 - **Direct Savings**
- **Qualitative Benefits**
 - **Improvements in Operational Capability**
 - **Objective Answers to Enhance User Confidence in Existing Data and Information**
 - **Standards and Specifications for Normalization of Data and Methods Used Elsewhere**



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Defense Technical Information Center • IAC Program

DoD IAC Full-Service Supermarket



GLOBAL SURVEILLANCE & COMMUNICATIONS



STRATEGIC FORCES AND MISSIONS

**PREPARED BY
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SYNERGISM OF STRATEGIC AND TACTICAL WEAPONS TECHNOLOGIES

CONTEXT

- THE ARMY MATERIAL COMMAND - SMART WEAPONS MANAGEMENT OFFICE (SWMO) TASKED GACIAC IN JUNE 1993 TO MAKE A QUICK TURN-AROUND COMPARISON OF STRATEGIC DEFENSE INITIATIVE (SDI) TECHNOLOGIES AND TACTICAL WEAPONS TECHNOLOGIES (TWT).
- THE PURPOSE WAS TO IDENTIFY AREAS WHERE SWMO, THE JOINT SERVICE GUIDANCE AND CONTROL COMMITTEE (JSGCC), AND GACIAC HAVE TRIED TO CAPTURE SDI TECHNOLOGY FOR USE BY THE TACTICAL WEAPONS COMMUNITY.

**GACIAC HAS ALWAYS INCLUDED STRATEGIC TECHNOLOGY
THAT HAD TACTICAL APPLICATIONS IN ITS DATABASE**



GACIAC AND STRATEGIC TECHNOLOGY

PROBLEM / NEED

TO INCLUDE ALL GUIDANCE AND CONTROL TECHNOLOGY IN THE GACIAC DATABASE THAT HAD REFERENCE TO TACTICAL WEAPONS APPLICATIONS

APPROACH

BOTH THE JSGCC AND GACIAC ORIGINAL CHARTERS SPECIFIED TACTICAL APPLICATIONS ONLY.

IT WAS PROPOSED AT A MEETING OF THE JSGCC IN 20-21 APRIL 1989 THAT "TACTICAL" BE DROPPED FROM BOTH CHARTERS

METHODOLOGY

- GACIAC CHARTER OF 11 SEPTEMBER 1992 COVERS ALL G&C TECHNOLOGY
- SDIO HAS BEEN INVITED TO OSD REVIEWS OF G&C SCIENCE AND TECHNOLOGY
- GACIAC HAS MET A NUMBER OF TIMES WITH THE STRATEGIC DEFENSE INITIATIVE TECHNICAL INFORMATION CENTER WHICH IS ALSO OPERATED BY IITRI

PRODUCTS

- 15 TO 20 PERCENT OF THE GACIAC DATABASE IS CONCERNED WITH STRATEGIC TECHNOLOGY
- GACIAC ASSISTED WITH U.S. ARMY STRATEGIC DEFENSE COMMAND SPONSORED CONFERENCE EACH OF THE PAST FOUR YEARS



COMPARISON OF SDI VS. TWT

PROBLEM / NEED

TO COMPARE STRATEGIC
DEFENSE INITIATIVE (SDI)
TECHNOLOGY TO TACTICAL
WEAPONS TECHNOLOGY
(TWT)

APPROACH

BEFORE 1984

- EFFORTS WHICH ARE NOW UNDER SDI WERE MANAGED TOGETHER WITH ALL OTHER DOD S&T PROGRAMS VIA A SINGLE MANAGEMENT CHAIN
- AT LABORATORY LEVEL, THE SAME GROUP OF SCIENTISTS AND ENGINEERS ADDRESSED TACTICAL AND STRATEGIC DEFENSE TECHNOLOGIES

1984-TODAY

- SEPARATION OF DOD S&T MANAGEMENT CHAIR INTO TWO CHAINS
- SDI INVESTMENT STRATEGY DEVELOPED, FOLLOWED BY IMPLEMENTATION PHASE
 - USING A JOINT SDI/TWT TECHNOLOGY BASE POOL
 - HEAVY INFUX OF TECHNOLOGIES
 - ADAPTATION OF THESE TECHNOLOGIES TO SDI
- INITIATION OF KEY TECHNOLOGY DEMONSTRATION EXPERIMENTS
- AT WORKING LEVEL, SEPARATION BETWEEN TWT & SDI TECH. EFFORTS MIN TODAY
- SUBSTANTIAL PROGRESS IN SDI'S KEY TECH. DEMONSTRATION EXPERIMENTS
- FIRST SDI DEVELOPED TECHNOLOGIES APPEARING
- POLARIZATION OF SDI & TWT

METHODOLOGY

COMPARE THE FOLLOWING AREAS
OF SDI AND TWT TO DEFINE
TECHNOLOGY TRANSFER

- SURVEILLANCE TECHNOLOGY
- ROCKET PROPULSION
- WARHEAD TECHNOLOGY
- GUIDANCE AND CONTROL

PRODUCTS

UNIQUE PERFORMANCE REGIMES

ELECTROMAGNETIC SPECTRUM	FULL SPECTRUM	ATMOSPHERIC
KILL MECHANISM	KE/DEW	WINDOWS
IMPACT VELOCITY	8-20 KM/SEC	EXPLOSIVES/
RADIATION HARDENING	1 MEGARAD +	KE/SC/DEW
ALTITUDE	100 KM +	< 8 KM/SEC
ROCKET PROPULSION	LARGE REUSABLE/	< 10,000 RAD
POWER SUPPLIES	SMALL EXPENDABLE	0-100 KM
AUTOMATIC TARGET RECOGNITION	LONG TERM/	EXPENDABLE
	UNATTENDED	SHORT TIME/
	BENIGN BACK-	SERVICEABLE
	GROUND	EXTREME
		CLUTTER



SURVEILLANCE TECHNOLOGY*

SDI APPLICATIONS

CONVENTIONAL WEAPONS TECHNOLOGY

BOOST PHASE
SURVEILLANCE AND
TRACKING SYSTEMS
(BSTS)

PASSIVE IR TECHNOLOGY, LARGE
SCALE OPTICS. SPACE RELEVANT

SPACE BASED
SURVEILLANCE AND
TRACKING SYSTEM
(SSTS)

PASSIVE SENSORS. SPACE RELEVANT

GROUND BASED RADAR
(GBR)

SOTA X BAND RADAR

CARRIER VEHICLE (CV)

PRIMARY SPACE RELEVANT
ACTIVE/PASSIVE SENSORS

AIRBORNE OPTICAL
SYSTEM (AOS)

COULD BE MAJOR CONTRIBUTOR TO
TACTICAL SURVEILLANCE

* ALMOST ALL SYSTEMS COULD PROVIDE CUEING FOR AIR DEFENSE/ATM SYSTEMS

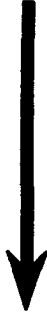


ROCKET PROPULSION*

SDI APPLICATIONS

CONVENTIONAL WEAPONS TECHNOLOGY

KINETIC KILL VEHICLE (KKV),
AXIAL



SOLID SOTA/TECH BASE

KINETIC KILL VEHICLE (KKV),
DIVERGENT



LIQUID SOTA/TECH BASE
MINIATURE QUICK OPENING VALVE

HIGH ENDOATMOSPHERIC
DEFENSE INTERCEPTOR
(HEDI) STAGES



FUTURE ATM OPTIONS

EXOATMOSPHERIC RE-ENTRY
VEHICLE INTERCEPT SYSTEM
(ERIS) STAGES



FUTURE ATM OPTIONS?

ADVANCED LAUNCH SYSTEM
(ALS)



NASA-AF-SDI PROGRAM

ATTITUDE CONTROL
THRUSTERS



SATELLITE SOTA

* ALL US ROCKET PROPULSION TECHNOLOGY IS REVIEWED ANNUALLY IN MEETINGS OF THE JOINT ARMY, NAVY, NASA, AIR FORCE (JANNAF) INTERAGENCY CHEMICAL PROPULSION COMMITTEE WITH ASSISTANCE OF CHEMICAL PROPULSION INFORMATION AGENCY (CPIA)



WARHEAD TECHNOLOGY

SDI APPLICATIONS

CONVENTIONAL WEAPONS TECHNOLOGY

KINETIC KILL VEHICLE (KKV),

> 8 KM/SEC THRESHOLD

SPACE BASED
HYPERVELOCITY GUN (HVG)

> 8 KM/SEC THRESHOLD

GROUND BASED
HYPERVELOCITY GUN (HVG)

ARMY - DARPA - SDI EFFORTS

HIGH ENDO ATMOSPHERIC
DEFENSE INTERCEPTOR (HEDI)

EXPLOSIVE FRAGMENT SOTA

EXOATMOSPHERIC RE-ENTRY
VEHICLE INTERCEPT SYSTEM
(ERIS)

UNIQUE SPACE WARHEAD

GUIDANCE AND CONTROL

SDI APPLICATIONS

BRILLIANT PEBBLES



MOSTLY SPACE RELEVANT EXCEPT
LOW COST IMU

GUIDED HYPERVELOCITY
GUN PROJECTILE



SDI--SURVIVABLE ELECTRONICS
SDI--COMMAND GUIDANCE

HIGH ENDOATMOSPHERIC
DEFENSE INTERCEPTOR (HEDI)



PASSIVE IR HOMING. ADVANCES IN
WINDOWS USING SOTA. FUTURE
PAYOFF TO ATM.

EXOATMOSPHERIC RE-ENTRY
VEHICLE INTERCEPT
SYSTEM (ERIS)



COMMAND UPDATE.
PASSIVE IR HOMING



RESULTS OF ANALYSIS TO TACTICAL APPLICATIONS

- CONTRIBUTED TO OVERALL S&T POOL
- DESIGNED SMALL, ACCURATE INERTIAL MEASUREMENT UNITS
(IMU)
- ADVANCED INFRARED SENSOR AND WINDOW TECHNOLOGY
- DEVELOPED EM GUN COMPONENTS
- MADE MIMIC VIABLE
- LAID THE FOUNDATION FOR THE SAM/ATM OF THE FUTURE
- PROVIDED POTENTIAL UPGRADE OF SPACEBORNE
SENSOR CUEING OF TACTICAL WARFARE

**INQUIRY RESPONSE RELATED TO
GLOBAL SURVEILLANCE**

Prepared by

**Ronald H. Bogaard
High Temperature Materials Information Analysis Center
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2595 Yeager Road
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Approved for Public Release; Distribution is Unlimited

CONTEXT

- **BROAD OBJECTIVE OF DOD S&T THRUST AREA ON GLOBAL SURVEILLANCE AND COMMUNICATIONS**
 - "The ability to project power requires a global surveillance and communication capability that can focus on a trouble spot, surge in capacity when needed, and respond to the needs of the commander." [*Defense Science and Technology Strategy*, p. ES-3, July 1992. AD-A253 691]
- **BROAD OBJECTIVE OF DOD KEY TECHNOLOGY AREA ON SENSORS**
 - "Sensor technology focuses on developing and applying fundamental principles and devices for sensor systems using random sensors, electrooptics sensors, acoustics, and multisensor integration." [*DoD Key Technologies Plan*, p. 3-1, July 1992. AD-A253 692]
- **DOD MILITARY MISSION/FUNCTION**
 - Air Superiority/Air Defense
 - Domestic Technology Transfer

HTMIAC BASIC INFORMATION PRODUCT

- **SUBSET OF DOD S&T THRUST AREA:**
 - **Advanced sensors are required for collection of a variety of parameters under numerous conditions**
- **FOCUS: BIBLIOGRAPHIC SEARCH FOR PROPERTY DATA ON EMERGING MATERIALS**
 - **What: Provide property data and information on two candidate materials for optical power-limiter applications.**
 - **Who: Air Force Wright Laboratory, Materials Directorate (Dr. Koto White), WPAFB**
 - **Form: Analyzed bibliography from current literature for electrooptic, photorefractive, nonlinear, and photochromic properties of V_xO_y and $Bi_{12}SiO_{20}$ (BSO) materials**

HTMIAC METHODOLOGY

- **METHODOLOGY EMPLOYED**
 - **Data Collection:** key-word search of DROLS, various commercial bibliographic databases (COMPENDEX, INSPEC, NTIS, CAS), and in-house bibliographic databases.
 - **Data Analysis:** How well do search strategy results match up with the user's question?
 - o Source document must be available for analysis.
 - o What data variables are required to adequately describe the material and property?
 - o Is the number of years spanned by the search adequate?
 - **Data Synthesis for Dissemination**
 - o Search results are organized according to findings of the analysis.
 - o Does user request document citation only or abstract also?
 - o Results are assembled from various searches.

HTMIAC METHODOLOGY (continued)

- **APPROACH FOLLOWED**
 - **Features**
 - **Searches can be conducted for any topic within HTMIAC scope.**
 - **Bibliographic databases searched include: DROLS, COMPENDEX, INSPEC, NTIS, and CAS.**
 - **Retrospective searches can be conducted for any time span.**
 - **Document sources encompass DoD and other government reports, journal articles, conference proceedings, books, etc.**
 - **All pertinent existing information is accessed.**
 - **New information is created in the form of an analyzed and evaluated bibliographic compilation.**

SUMMARY OF DATA

- DATA COLLECTED
 - Bibliographic Search Results:
 - For BSO: 142 bibliographic records for electrooptic, photorefractive, nonlinear, and photochromic properties from DROLS, INSPEC, COMPENDEX, and in-house files.
 - For V_xO_y : 143 bibliographic records for electrooptic, photorefractive, nonlinear, and photochromic properties from DROLS, INSPEC, COMPENDEX, and in-house files.
 - Interesting Characteristics:
 - One material (V_xO_y) finds use in applications (lithium battery electrodes) quite different from the initial question, but of interest nonetheless.
 - Real differences in search results exist among various bibliographic databases.
 - INSPEC contains basic science type bibs.
 - COMPENDEX contains applications type bibs (< 20% overlap with INSPEC).
 - DROLS hits are comparatively few (HTMIAC is being challenged to incorporate more materials of this type).

RESULTS OF DATA ANALYSIS

- **FINDINGS RESULTING FROM ANALYSIS OF THE COLLECTED DATA**

- Considerable interest exists for ongoing research of emerging sensor materials.
- The fact that most of the source literature is journal articles means that dual-use and commercial applications are being anticipated.
- One material (V_xO_y) happens to be important for applications (lithium battery electrodes) in a totally different key technology area (energy storage).

- **SUMMARY OF TECHNICAL RECOMMENDATIONS**

- HTMIAC is more than willing to conduct data searches for materials and properties that are of emerging as well as current technological importance.
- HTMIAC will search for candidate data sources from all available bibliographic databases to ensure balanced, comprehensive coverage of a given topic.

CONSEQUENCES

- **WHAT HAS HAPPENED AS A RESULT OF COMPLETION OF THIS INQUIRY?**
 - The resulting bibliography provides the needed information to the Air Force Wright Laboratory on candidate materials for optical power-limiter applications.
 - **Financial Benefits to DoD**
 - o Savings from having available a "better" search result (more hits due to searching several bibliographic databases).
 - o Savings from having HTMIAC conduct the searches.

RELEVANCE TO OTHER USERS

- **RELATED SUBSTANTIVE PROBLEMS FOR WHICH HTMIAC PRODUCT WOULD BE RELEVANT**
 - A subset of the resulting bibliography on V_xO_y should be of interest to users working on lithium battery electrodes
- **ANALOGOUS PROBLEMS FOR WHICH HTMIAC PRODUCT WOULD BE RELEVANT BECAUSE OF THE METHODOLOGY USED**
 - Methodology used in this work for the collection and analysis of materials' bibliographic information can be used for any materials and properties
 - A balanced matchup of bibliographic results with user requirements is ensured by searching a selection of available bibliographic databases

**AIR SUPERIORITY AND GLOBAL SURVEILLANCE:
SHIPBOARD INFRARED SEARCH AND TRACK
SENSORS**

Presented by:

**Rodney C. Anderson
Director**

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**Ann Arbor, MI 48113
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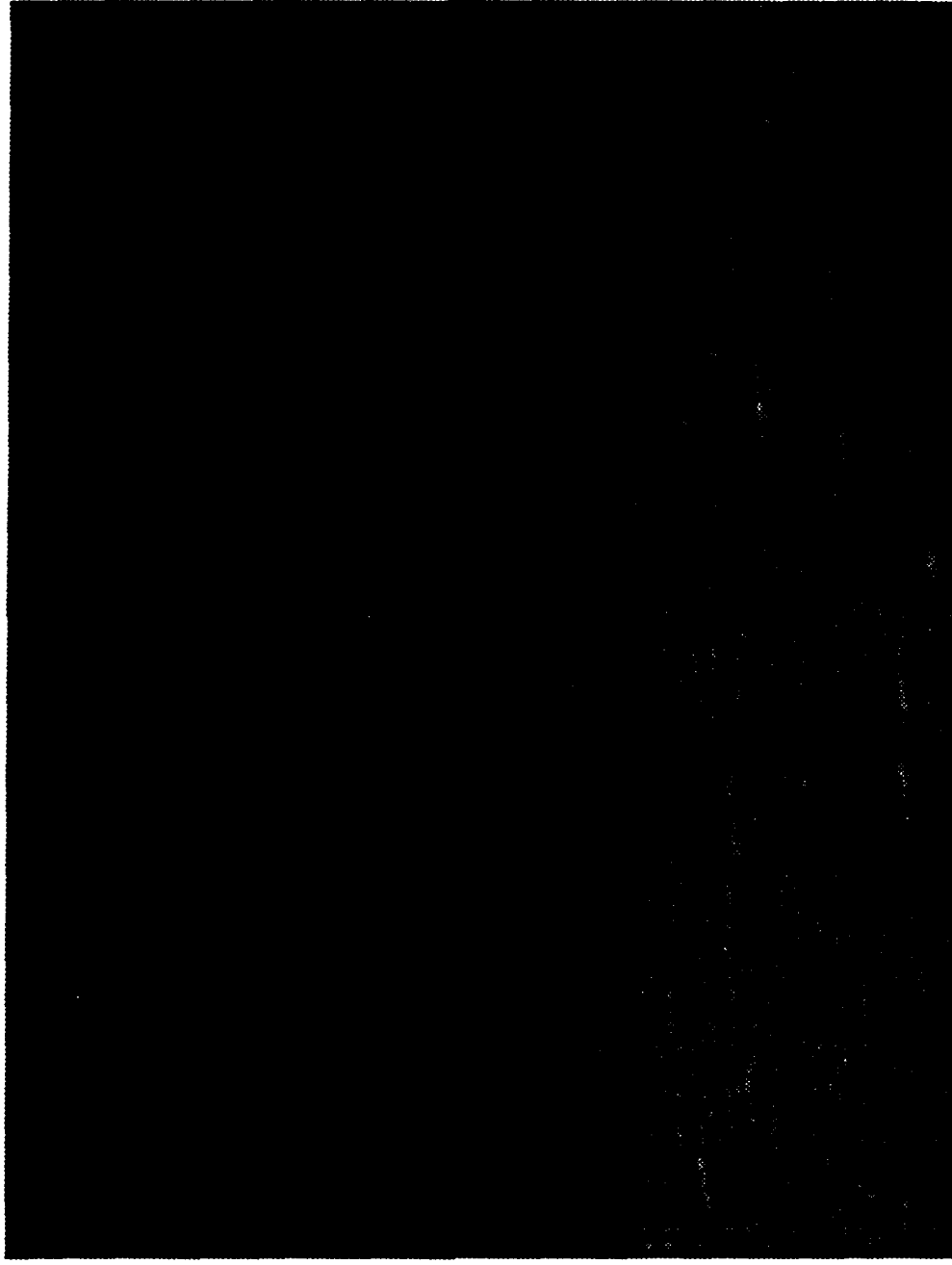
SHIPBOARD INFRARED SEARCH AND TRACK SENSOR TECHNOLOGY

- **Context:** High speed sea-skimming cruise missiles pose a severe threat to Navy ships, especially those operating in littoral environments
- **Objective:** Provide infrared data and models to support the development of a shipboard infrared search system technology base. This tech base will be used to support demonstration of a seagoing SIRST.
- **Technology area:** Sensors (passive electro-optical)
- **Thrusts supported:** Air superiority
- **Missions:** Naval surface
 - Power projection
 - Naval shore bombardment
 - Amphibious forces support
 - Sea control

SIRST TECHNICAL AREA TASK

- **Support sensor development**
- **Several support methods**
 - **Use available handbook and data to calculate generic signature levels for generic targets. Handbook type data are appropriate for the level of approximation necessary for bounding the threat parameter space.**
 - **Use phenomenological models to provide insights into effects important toIRST processing. (chart from SIRST final report)**
 - **Incorporate other IAC models and data to generate threat profiles.**
 - o **Blue Max model (SURVIAC) used to generate flight path for Incoming cruise missiles**
 - o **Guidance and control system algorithms used to evaluate cruise missile paths (GACIAC)**
 - **Used IRIA electronic file transfer capability to transfer up to date information**

INFRARED OCEAN SCENE



Prepared by: R. Anderson

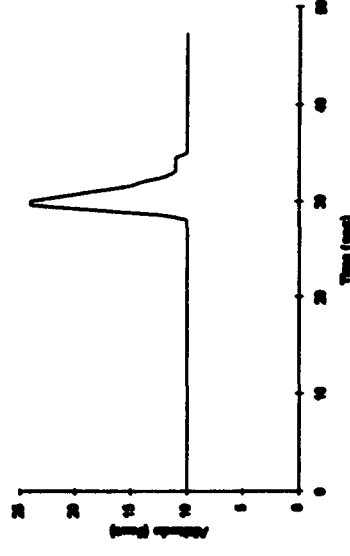
IRIA-4

Intercept



METHODOLOGY

- ISSUES
 - Vehicle reflectance properties influence signature
 - Atmospheric and background properties dominate performance
 - Vehicle maneuvers constrain signal processing approach
 - Missile guidance mode impacts processing requirements
- APPROACH
 - Use IRIA reflectance prediction code
 - Extract statistics from IRIA handbooks and databases
 - Use Blue Max code (SURVIAC) to predict flight path
 - Consult with guidance experts (GACIAC)



TASK SUMMARY

- **RESULTS**
 - Predicted dynamic signatures of generic targets
 - Quantified effects of target motion
 - Estimated sensor performance for several scenarios
- **TECHNICAL RECOMMENDATIONS**
 - Include higher order signature effects in modeling and prediction
 - Ground truth needed for assessment of atmospheric propagation
 - Algorithm development must be closely linked to phenomena

CONSEQUENCES

- **FINANCIAL BENEFIT**
 - Algorithm development plan improved
 - Focussed background data acquisition
- **PERFORMANCE BENEFITS**
 - Reduced development risk
 - Improved detection capability

TASK RELEVANCE

- **IRST TECHNOLOGY RELEVANT TO:**
 - **Situation awareness**
 - **Collision avoidance**
 - **Passive air traffic control**
 - **Counter low observables**
 - **Missile seeker development**
- **TASK METHODOLOGY RELEVANT TO:**
 - **General automated passive remote sensing problem**
 - **Automated machine vision**
 - **Airborne/ ground based passive IR sensing**

ASSESSMENT OF ULTRA-WIDEBAND (UWB) RADAR TECHNOLOGY

Prepared by

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Approved for Public Release: Distribution Unlimited

[The final report for this study is Limited Distribution and/or Classified. AD B146 160]

CONTEXT

- **DoD S&T THRUSTS 1: GLOBAL SURVEILLANCE AND COMMUNICATIONS, 2: PRECISION STRIKE, AND 3: AIR SUPERIORITY AND DEFENSE**
- **DoD KEY TECHNOLOGIES: SENSORS/RADAR SENSOR TECHNOLOGY**
- **DoD MILITARY MISSIONS/FUNCTIONS: STRATEGIC FORCES, AIR DEFENSE**

Prepared by: V. G. Pugliese-Battelle/
L. W. Williams-TWSTIAC

TWSTIAC-2

Pugliese.vu

TWSTIAC TASK/BASIC INFORMATION PRODUCT

TWSTIAC WAS ASKED TO:

- **EXAMINE THE STATE OF THE ART AND POTENTIAL BENEFITS OF UWB TECHNOLOGY, PARTICULARLY FOR RADAR APPLICATIONS**
- **IDENTIFY AND PRIORITIZE RESEARCH TO BE PURSUED**

Prepared by: V. G. Puglielli-Battelle/
L. W. Williams-TWSTIAC

TWSTIAC-3

Puglielli, vu

TWSTIAC METHODOLOGY

- **BLUE RIBBON PANEL OF RESIDENT AND NATIONAL EXPERTS ON UWB TECHNOLOGY AND RADAR**
- **REVIEWED PRIOR UWB RADAR DEVELOPMENT**
 - **Experimental data**
 - **Literature--including Soviet**
- **REVIEWED ONGOING AND PROPOSED WORK**
 - **Government laboratories**
 - **Industry and academia**
- **DETERMINED POTENTIAL PERFORMANCE BENEFITS**
 - **Radar technologies, including against low-observable targets**
 - **Countermeasures, especially probability of detection**

Prepared by: V. G. Puglielli-Battelle/
L. W. Williams-TWSTIAC

TWSTIAC-4

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TWSTIAC METHODOLOGY (Continued)

- **IDENTIFIED TECHNOLOGY ISSUES/GAPS IN KNOWLEDGE/
PRIORITY OF IMPORTANCE**
- **RECOMMENDED NEEDED RESEARCH**
 - **Areas for further investigation**
 - **Experimental tools/hardware needed**
- **DETERMINED POSSIBLE APPLICATIONS**

Prepared by: V. G. Puglielli-Battelle/
L. W. Williams-TWSTIAC

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ASSISTANCE DELIVERED

- **CONCENTRATED ON CHARACTERISTICS OF AND CLAIMS MADE FOR UWB TECHNOLOGY: RADAR, COMMUNICATIONS, ELECTRONIC WARFARE AND RF WEAPONIZATION**
 - **No applications were advanced for communications**
 - **Government in-house committee was addressing applications to EW and RF weaponization**
 - **Therefore, this study concentrated on radar applications**
- **FOCUSED ON CLAIMS FOR ULTRA-WIDEBAND "IMPULSE" RADAR AS BEING INHERENTLY:**
 - **Counter-stealth (i.e., to defeat the F-117 and the B-2)**
 - **Low Probability of Intercept (LPI) (to defeat countermeasures)**
 - **Capable of detecting relocatable targets in camouflage/foliage**
- **REVIEWED THE THEORETICAL BASES FOR CLAIMED CAPABILITIES**

Prepared by: V. G. Pugliese-Battelle/
L. W. Williams-TWSTIAC

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Pugliese, vu

RESULTS OF DATA ANALYSIS

- **IMPULSE RADAR IS NOT INHERENTLY COUNTER-STEALTH**
 - Conventional radars are able to exploit any vulnerabilities resulting from target shaping
 - No effects in RAM are unique to impulse radar
- **IMPULSE RADAR IS NOT INHERENTLY DIFFICULT TO DETECT**
 - It is difficult to make any radar hard to detect
 - Impulse radar has no special LPI characteristics, is readily detected by an appropriately designed intercept receiver
- **A PROPERLY DESIGNED IMPULSE RADAR MIGHT BE ABLE TO DETECT TARGETS SHIELDED BEHIND TREES (AS MIGHT ANY NON-IMPULSE UWB RADAR)**

Prepared by: V. G. Pugliesi-Battelle/
L. W. Williams-TWSTIAC

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RESULTS (Continued)

- **ADVANCES IN SOURCES FOR VERY HIGH POWER SHORT PULSES MIGHT BENEFIT CONVENTIONAL SHORT PULSE RADAR AS WELL AS IMPULSE TRANSMITTERS**
- **CONVENTIONAL RADAR THEORY IS COMPLETELY ADEQUATE FOR UNDERSTANDING IMPULSE RADAR PHENOMENA--THERE IS NO UNIQUE THEORETICAL BASIS FOR UWB RADAR**
- **RECOMMENDATIONS WERE MADE:**
 - **Do analyses of point designs using both impulse and non-impulse radar approaches for four military applications**
 - **Do studies of clutter behavior of UWB radar systems and characteristics of UWB antennas**
 - **Do a modest study to document characteristics of self-induced transparency and other non-linear effects possibly relevant to military systems**

Prepared by: V. G. Puglielli-Battelle/
L. W. Williams-TWSTIAC

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CONCLUSIONS

- **INTERESTING WORK WAS UNDER WAY, AND SELECTED/LIMITED R&D INVESTMENTS COULD EXPLORE ITS POTENTIAL BENEFITS**
- **IMPULSE RADAR DOES NOT OFFER A MAJOR NEW MILITARY CAPABILITY, NOR DOES IT THREATEN A SERIOUS TECHNOLOGICAL SURPRISE**

**Prepared by: V. G. Puglielli-Battelle/
L. W. Williams-TWSTIAC**

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CONSEQUENCES

- **WHAT HAS HAPPENED AS A RESULT OF THIS EFFORT?**

- **Financial benefits to DoD**

- Congress had mandated \$25M FY90 funds be spent on this technology. This effort helped to focus investment of \$10M FY90-91 and \$12M FY92-93 funding for UWB into theoretically sound, technologically promising, and operationally appropriate R&D
- Avoided "Loss Leader" construction of an unnecessary UWB radar site-- future investments could have been multiples of \$25M

- **Other benefits to DoD**

- Disproved unfounded challenges against the viability of stealth technologies
- Discredited claims that the U.S. was at risk of major technological surprise
- Brought some discipline and technical foundation to a highly visible, poorly described technology as an aid to decision makers
- Laid the foundation for subsequent technology developments which are significant for several applications, the most notable proving to be foliage penetration radar.

Prepared by: V. G. Pugliesi-Battelle/
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RELEVANCE TO OTHER USERS

- **THE METHODOLOGY OF A "BLUE RIBBON" TEAM OF HIGH QUALITY/INTEGRITY UNDER IMPARTIAL ORGANIZATIONAL LEADERSHIP CAN BE APPLIED TO ANY PROBLEM WHERE TECHNICAL CONFUSION IS WIDESPREAD AND UNUSUAL CLAIMS MAY BE THE BASIS FOR DoD INVESTMENT**
- **THE REPORT STANDS AS A SOUND GUIDE FOR FUTURE PLANNERS IN THIS TECHNOLOGY. THE BASIC PHYSICS WHICH FORMS THE REPORT'S FOUNDATION WILL NOT CHANGE WITH TIME. THE TECHNOLOGY CONTINUES TO ADVANCE ALONG THE LINES PREDICTED.**

Prepared by: V. G. Puglielli-Battelle/
L. W. Williams-TWSTIAC

TWSTIAC-11

Puglielli vu

PRECISION STRIKE

OBSERVATIONS OF ACOUSTIC SURFACE WAVES PROPAGATING ABOVE A SNOW COVER

Presented by

**Peter D. Smallidge
CECRL-ORTA**

Authored by

**Dr. Donald G. Albert, CECRL-RG
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CONTEXT

- **DOD KEY TECHNOLOGY**
 - Environmental Effects: The automated generation of near-real-time environmental tactical decision aids to determine the adverse effects of dynamic battlefield environments on characterization and modeling of military requirement and operations.
- **DOD SCIENCE AND TECHNOLOGY THRUST**
 - Precision Strike: Against critical mobile and fixed targets in all-weather; day/night; and foliage- and camouflage-resistant environments.
- **DOD CRITICAL TECHNOLOGY**
 - Signal and Image Processing
 - » Combination of computer architecture, algorithms, and microelectronic signal processing devices for near real-time automation of detection, classification, and tracking of targets.
 - Weapon System Environment
 - » A detailed understanding of the natural environment and its influence on weapons system design and performance.

IAC TASK / BASIC INFORMATION PRODUCT

- **TECHNICAL ISSUE**

- Seismic and acoustic waves are useful for non-line-of-sight surveillance and targeting , but are greatly affected by ground conditions, especially in cold regions (snow, ice, frozen ground).

- **IAC PRODUCT FOCUS**

- Literature search on acoustic coupling processes
- Survey of acoustic modeling concepts for porous media
- Analysis of relevant approaches to simulate effects of snow cover
- Customers: U.S. Army Engineer School; U.S. Army Armament RD&E Center

Prepared by: P. D. Smallidge

IAC-ACOU-2

SUMMARY OF FINDINGS

- **RESEARCH OBJECTIVE**

- Gain an understanding of winter environmental effects on seismic and acoustic waves.
- Develop predictive capabilities applicable to NLOS surveillance and targeting systems.

- **RESEARCH APPROACH**

- Combine experimental, theoretical and computational approaches to understand and predict winter impact on seismic and acoustic waves.

- **SURVEY FINDINGS**

- Little understanding of:
 - » Dominant propagation modes
 - » Critical properties (wave speed, attenuation rate)
 - » Controlling environmental parameters
- Biot's Theory offers analysis approach

CONSEQUENCES

- **RESULTS**

- High attenuation rates for atmospheric acoustic waves above snow covers.
- Theoretical definition of dominant energy propagation modes in porous media.
- Permeability is controlling factor.
- Practical model developed to predict signal characteristics for varying environmental conditions.

- **IMPACT**

- Ability to predict ground sensor performance for a wide range of conditions.
- Applicable to future NLOS sensor development and current systems such as Wide Area Mine.

RELEVANCE TO OTHER USERS

- **PHYSICAL SECURITY SYSTEMS**
 - Sensor performance, design, and evaluation
- **ENVIRONMENTAL QUALITY**
 - Noise abatement predictions

Prepared by: P. D. Smallidge

IAC-ACOU-5



**SMART WEAPONS OPERABILITY
ENHANCEMENT (SWOE) PROGRAM**

Presented by

**Peter D. Smallidge
CECRL-ORTA**

Program Manager

**Dr. James P. Welsh, CECRL-SW
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Approved for Public Release: Distribution Unlimited

CONTEXT

- **DOD SCIENCE AND TECHNOLOGY THRUST**
 - Synthetic Environments: Provide computer- and electronics-based technology for development, testing, training and readiness to synthesize factory-to-battlefield environments.
 - Precision Strike: Against critical mobile and fixed targets in all-weather; day/night; and foliage- and camouflage-resistant environments.
- **DOD KEY TECHNOLOGY**
 - Environmental Effects: The automated generation of near-real-time environmental tactical decision aids to determine the adverse effects of dynamic battlefield environments on characterization and modeling of military requirement and operations.
- **DOD CRITICAL TECHNOLOGY**
 - Simulation and Modeling
 - Weapon System Environment

IAC TASK / BASIC INFORMATION PRODUCT

- **ARMY TECHNOLOGY BASE MASTER PLAN**

- Science and Technology Objective, VI.C.5., Smart Weapons Operability Enhancement
 - » Develop analytical IR and MMW models to robustly simulate geographical and time/weather driven character of environmental scenes.
 - » Develop validated multi-sensor scene generation capability for quantitative consideration of environmental conditions in the design, test and evaluation of smart weapon and ATR devices.

- **IAC PRODUCT FOCUS**

- Survey and analyze environmental science technologies to support development of an integrated, physics based, scene generation process.
 - » Measurement and Information Bases
 - » Analytical Models
 - » Scene Rendering Software
- Customer:
 - » OSD Joint Test & Evaluation Program
 - » U.S. Army Smart Weapons Management Office
 - » Individual Emerging Systems

SELECTED PRODUCTS SWOE PROGRAM

- **88-1, Program Implementation Plan, USACRREL, Jan 89**
- **90-1, One-Dimensional Temperature Modeling Techniques, EG&G Energy Measurements / SPARTA / NASA Goddard Space Flight Center, Aug 90**
- **90-8, Representative Weather Data Sets for Hunfeld, Federal Republic of Germany, USAASL, Jul 90**
- **90-9, Comparison of Climatologies of Selected SWOE Test Sites, USAASL, Aug 90**
- **90-15, Three Dimensional Modelling of Background Scenes at Millimeter Waves, MIT Research Lab. of Electronics, Dec 90**
- **92-1, Information Base Procedures for Generation of Synthetic Thermal Scenes, USAEWES, Feb 92**
- **92-2, Review of Environmental Research Specific to SWOE for the Battlefield Environment, USACRREL/USATEC/ USAEWES, Jun 92**
- **92-6, Data Analysis for Bark and Leaf Reflectance Measurements, Spectral Sciences, Inc./Phillips Lab., Jun 92**
- **93-1, A Review of Millimeter Wave Modeling, USACRREL, Mar 93**

IAC METHODOLOGY

- **DATA BASES**
 - Survey environmental data from military test sites
 - Analyze for
 - » Validity
 - » Range of relevant conditions
- **MODELS**
 - Initial survey of sensor models relevant to smart weapons - IR and MMW
 - Survey and compilation of IR models
 - Workshop to establish / synthesize MMW techniques
- **SIMULATION**
 - Survey government and commercial technologies
 - Evaluate based on smart weapon system drivers / parameters

SUMMARY OF FINDINGS

- **PERFORMANCE OF SMART WEAPONS SYSTEMS HAS BEEN UNPREDICTABLE AND UNRELIABLE FOR EXTRAPOLATION TO THE GLOBAL RANGE OF BATTLEFIELD CONDITIONS.**
 - Effects of the environment are treated in generic rather than specific ways.
 - There are no environmental criteria for development or testing. The environment is not defined in terms relevant to the performance of smart weapons.
 - Environment performance criteria are not keyed to the specific regions within which that system must operate.
- **OPTIONS TO SOLVE THE PROBLEM**
 - Real imagery data
 - Hybrid imagery
 - Synthetic imagery

CONSEQUENCES

- **RECOMMENDED APPROACH:**
 - Validated scene generation process
 - » Integrated physics based models
 - » Terrain and weather data base driver
 - » Workstation environment
 - Compatibility with Distributed Interactive Simulation
- **RESULT:**
 - Smart Weapon Operability Enhancement Joint Test & Evaluation (SWOE JT&E) program initiated in 1992, \$15.2M funding, 3 years
 - Impact: Early consideration of environment in design, optimization of testing, extrapolation of test results

RELEVANCE TO OTHER USERS

- **PHYSICAL SECURITY SYSTEMS**
 - Sensor performance design and evaluation
 - Criteria for logic design to reduce false alarms
- **REMOTE SENSING**
 - Mission planning
 - Image analysis criteria
 - New sensor design / evaluation

Prepared by: P. D. Smallidge

IAC SWOE -7



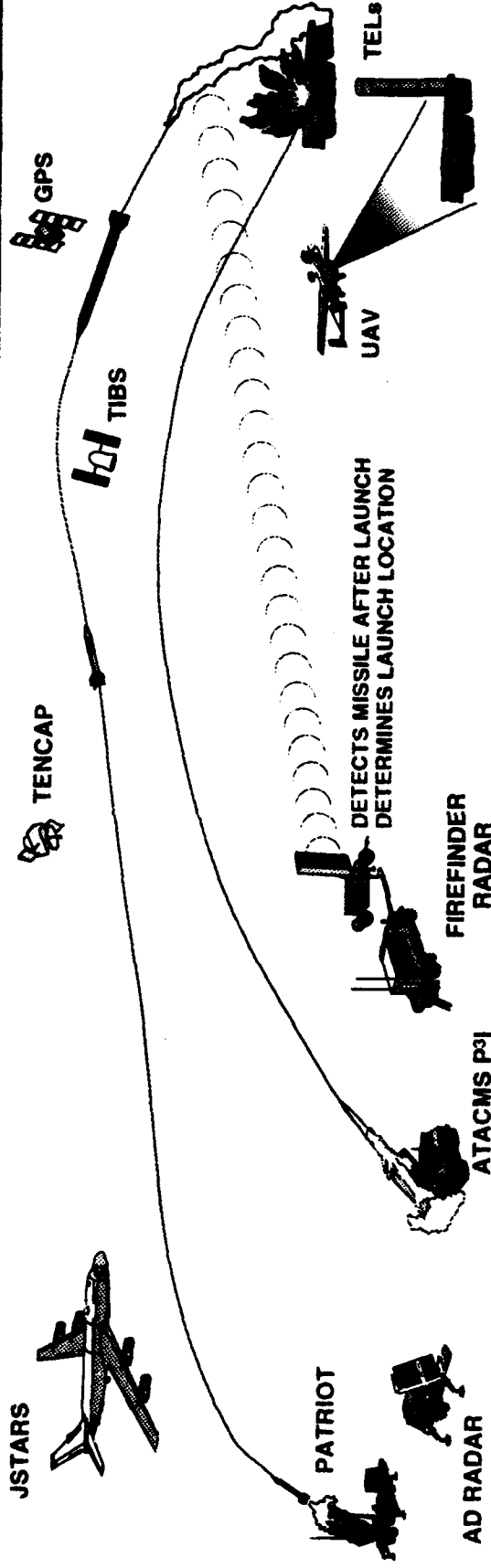
PRECISION STRIKE

PREPARED BY

JOSEPH J. PETROVIC

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PRECISION STRIKE CONTEXT



DEFINITION

- LOCATE HIGH VALUE, TIME-SENSITIVE FIXED AND MOBILE TARGETS (SCUDs/TBMss)
 - DESTROY THEM WITH A HIGH DEGREE OF CONFIDENCE
 - WITHIN A TACTICALLY USEFUL TIMELINE
- EFFECTIVE PRECISION STRIKE CAPABILITY**
- REDUCES CASUALTIES
PROVIDES ECONOMY OF FORCE
REDUCES DEMAND FOR WEAPON PLATFORMS

Presented By: **GACIAC**
J. J. PETROVIC

REQUIREMENTS

- TARGET ACQUISITION - DETECTS MISSILE BEFORE OR SHORTLY AFTER LAUNCH USING TENCAP, ENHANCED FIREFINDER, JSTARS, UAV ENDURANCE
- USES C3I NETWORK TO COUNTER / INTERCEPT INCOMING BALLISTIC MISSILES
- USE COUNTERFIRE / IEW ASSETS TO TRACK / ENGAGE TBM LAUNCHER
 - ENHANCED FIREFINDER (EnFF)
 - TACTICAL INFORMATION BROADCAST SYSTEM (TIBS)
- CONFIRM TARGETS STATUS WITH BATTLE DAMAGE ASSESSMENT (BDA)

PRECISION STRIKE BATTLE LABS/LOUISIANA MANEUVERS IAC TASK

- SUPPORTED TECHNOLOGY DEMONSTRATIONS OF SIX MISSILE SHOTS AT WHITE SANDS MISSILE RANGE (WSMR)
- EVALUATED ENHANCED FIREFINDER (TPQ-37 RADAR) ABILITY TO DETECT A TACTICAL BALLISTIC MISSILE (TBM) AT EXTENDED RANGES
- CONDUCTED A C³I TIME-LINE ANALYSIS OF THE DETECTION, TRACKING, AND COUNTERFIRE MISSILE EVENTS WITH THE D&SA BATTLE LAB AT FT. SILL
- SIMULATED THE USE OF JSTARS, UAV, FDDM, MLRS LAUNCHER FOR ATACMS WHILE ACTUALLY USING A TPQ-37 RADAR TRACKING A LAUNCH AT WSMR AND A TACFIRE AT FT. SILL, OK
- LATER LAUNCHES DETECTED AND TRACKED MISSILE WITH TPQ-37 RADAR AND HANDED OFF TRACK TO AN AIR DEFENSE NODE
- LOUISIANA MANEUVERS - CDRs / STAFF CAN USE REALISTIC C³I TIMELINES TO GAME / SIMULATE RESPONSE ALTERNATIVES

**GACIAC SPECIAL TASKS PROVIDED SUPPORT FOR CRITICAL TECH DEMO
THROUGH TRADOC BATTLE LABS / LOUISIANA MANEUVERS**

PRECISION STRIKE TRADOC BATTLE LABS

MOUNTED BATTLESPACE
FT. KNOX, KY

BATTLE COMMAND
FT. LEAVENWORTH, KS

DEPTH AND SIMULTANEOUS ATTACK
FT. SILL, OK

DISMOUNTED BATTLESPACE
FT. BENNING, GA

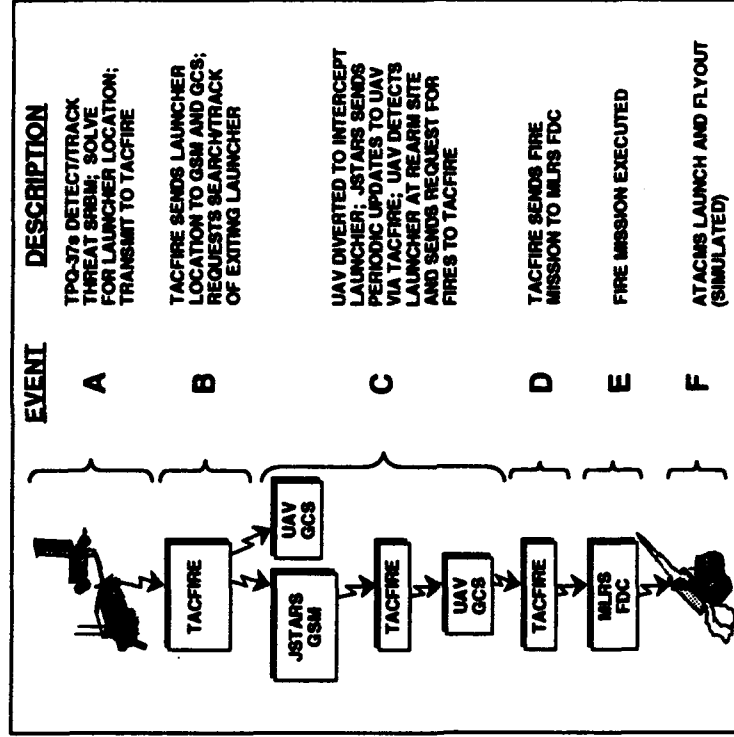
COMBAT SERVICE SUPPORT
FT. LEE, VA

EARLY ENTRY, LETHALITY
AND SURVIVABILITY
FT. MONROE, VA

- EXPLOIT DISTRIBUTED INTERACTIVE SIMULATION REVOLUTION
- BRING USER, LAB, AND INDUSTRY TOGETHER TO EVALUATE VIRTUAL PROTOTYPES, TECH DEMOS IN FIELD ENVIRONMENT, AND "HOW TO FIGHT" CONCEPTS
- HORIZONTAL INTEGRATION OF TECHNOLOGY FOR SYSTEM UPGRADES

Presented By: **GACIAC**
J. J. PETROVIC

PRECISION STRIKE TEST AND EVALUATION

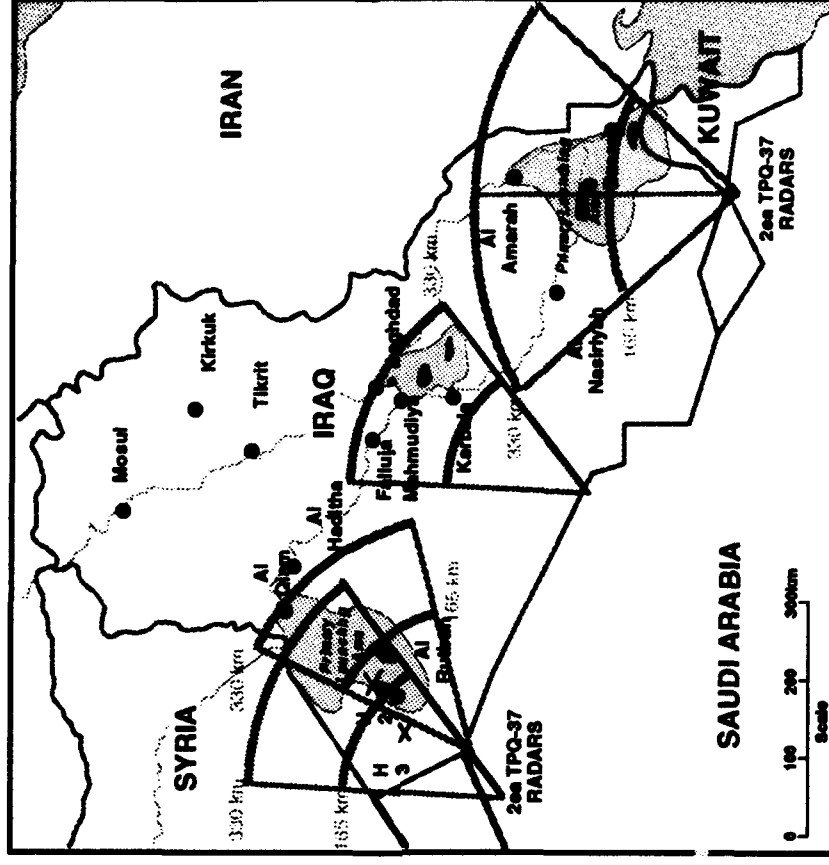


IACS ASSIST USERS IN EVALUATING PRECISION STRIKE
THROUGH REAL-TIME TEST AND EVALUATION

Presented By: **GACIAC**
J. J. PETROVIC

PRECISION STRIKE STUDIES & ANALYSIS

- CONDUCTED AN ASSESSMENT OF SCUD FIRINGS AGAINST ISRAEL AND SAUDI ARABIA DURING DESERT STORM
- EXAMINED THREAT TACTICAL BALLISTIC MISSILES (TBM) IN SWA (IRAQ) AND NEA (N. KOREA)
- PROJECTED ENHANCED FIREFINDER PERFORMANCE AGAINST TBM CONSIDERING RCS, TRAJECTORY, AND RANGE
- DETERMINED THE REQUIRED PERFORMANCE FOR THE BLOCK II FIREFINDER IMPROVEMENTS AND THE NUMBER OF SYSTEMS NEEDED TO PROVIDE COUNTRYWIDE COVERAGE



**IACS CAN PROVIDE PMs / PEOs / RDECs WITH INDEPENDENT
ANALYTICAL SUPPORT FOR SYSTEM P³I AND DoD S&T THRUST AREA**

Presented By: **GACIAC**
J.J. PETROVIC

PRECISION STRIKE COMMAND, CONTROL, COMMUNICATIONS, AND INTELLIGENCE

- DESERT STORM REVEALED WEAKNESSES IN U.S. ABILITY TO RESPOND TO SCUD / TBM THREAT
- STUDY REQUIRED TO APPRECIATE THE INTELLIGENCE INDICATORS AND SPECIFIC EVENTS
- DETECTION REQUIRES DEDICATION OF SELECTED TARGET ACQUISITION / IEW ASSETS AND NETTING OF SENSORS
- COUNTERING MISSILE REQUIRES EFFICIENT / TIMELY HANDOFF TO AIR DEFENSE SYSTEMS
- COUNTERING LAUNCHING / SUPPORT VEHICLES REQUIRES CAREFUL INTEGRATION / HANDOFF OF NATIONAL / SERVICE SENSOR DATA TO EXECUTE AN EFFECTIVE COUNTERFIRE MISSION
- IDEALLY, IDENTIFY ASSETS / LOCATION AND DESTROY PRE-EMPTIVELY
- IDENTIFY LAUNCH SITE ACCURATELY
- TRACK ACTIVITY AT LAUNCH SITE AND MOVEMENT TO HIDE
- DIVERT SENSORS TRACK / PROVIDE BATTLE DAMAGE ASSESSMENT (BDA)
- DIVERT ASSETS TO ENGAGE TARGET OR PROVIDE COUNTERFIRE MISSION TO DEDICATED ASSETS
- CONDUCT BDA TO KNOW REAL RESULTS

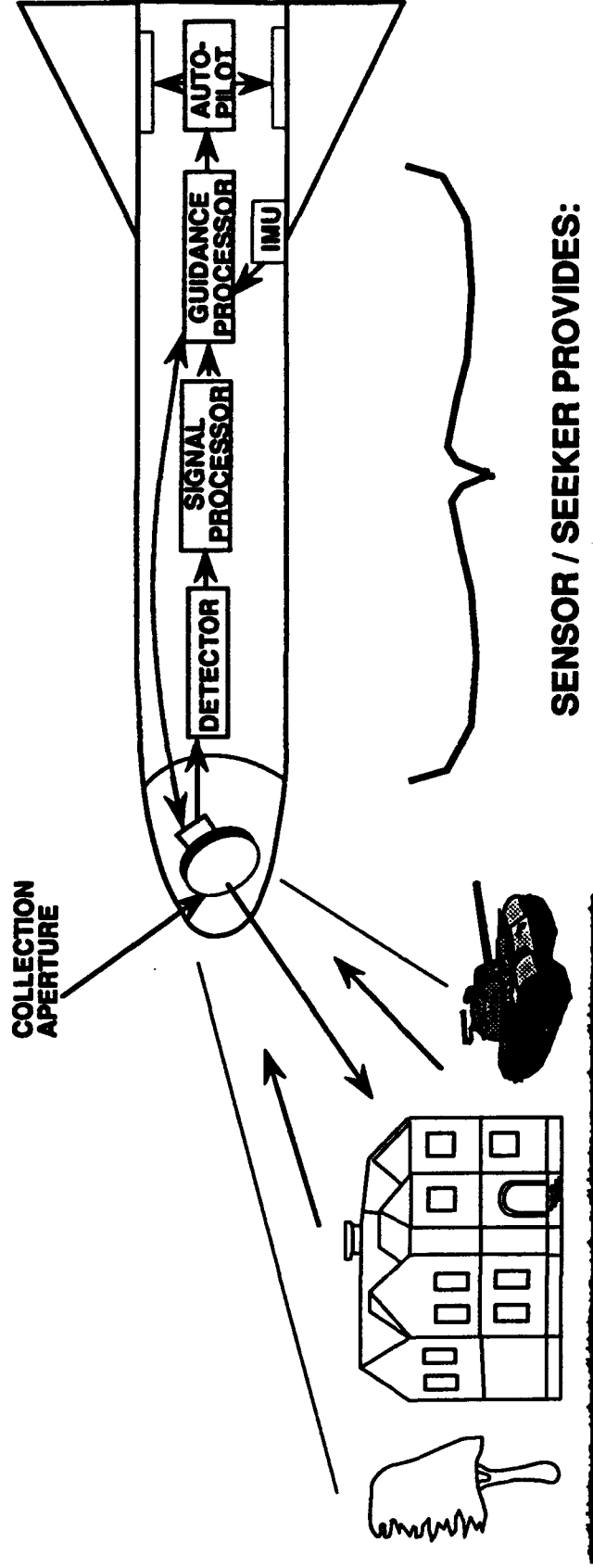
TIMELY C³I ESSENTIAL FOR EFFECTIVE PRECISION STRIKE



SENSORS AND ELECTRONIC DEVICES

**PREPARED BY
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SEEKERS / SENSORS CONTEXT



SENSOR / SEEKER PROVIDES:

- SENSING OF TARGET ATTRIBUTE IN THE DETECTOR -- USUALLY SOME FORM OF EMITTED OR REFLECTED ENERGY.
- TARGET DETECTION DECISIONS IN THE SIGNAL PROCESSOR BASED ON TRANSDUCED SIGNALS FROM THE DETECTOR.
- RELATIVE TARGET POSITION BASED ON APERTURE LINE-OF-SIGHT AND TRACKING ALGORITHMS IN THE SIGNAL PROCESSOR SEEKER/SENSOR.

SENSOR FOOTPRINT
INCLUDES
TARGET + CLUTTER
ATTRIBUTES



REPRESENTATIVE SEEKER/SENSOR ANALYSIS EFFORTS

TITLE

MULTISPECTRAL AIR-TO-AIR SEEKER (MSAAS)
 SMART TACTICAL AUTONOMOUS GUIDANCE (STAG)
 LOW COST ANTI-ARMOR SUBMUNITION (LOCAAS)
 LINE-OF-SIGHT ANTI-TANK (LOSAT) ANALYSIS
 ADVANCED SENSOR/SEEKER DEVELOPMENT
 BAT PREPLANNED PRODUCT IMPROVEMENT (P3I)
 US/JAPAN DUAL MODE SEEKER COOPERATIVE EFFORT
 BLUE VEHICLE SURVIVABILITY ASSESSMENT
 PASSIVE DET, TRKG, & ID -- GROUND VEHICLES
 FIELD DEMONSTRATION OF ACOUSTIC TRACKER
 MULTI SENSOR/TARGET TRACKING

SENSOR/SEEKERS
 IMAGING INFRARED
 ACTIVE / PASSIVE MMW
 ACOUSTIC
 LASER RADAR
 MULTIMODE / DUAL MODE
ALGORITHMS - ATR
 IMAGE PROCESSING
 NEURAL NETWORKS
 DATA FUSION
SIGNATURES
 DATA COLLECTION
 STRUCTURING & COMPILATION
 CHICKEN LITTLE DATA
TEST & EVAL
 LABORATORY
 FIELD (TOWER & CFT)
 HWIL

MULTIPLE CUSTOMERS

MULTIPLE SERVICES (ARMY, AIR FORCE, NAVY)
 DTIC
 ARPA
 RESEARCH, DEVELOPMENT, & ENGINEERING CENTERS
 LABORATORIES
 PROGRAM EXECUTIVE OFFICES
 PROGRAM MANAGEMENT OFFICES

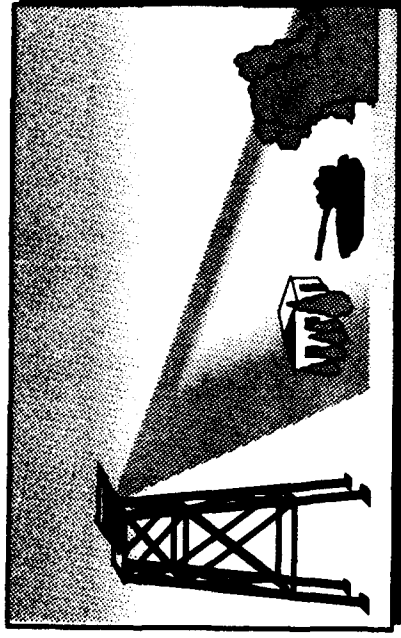
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INDEPENDENT SEEKER / SENSOR ANALYSES

OBJECTIVE:

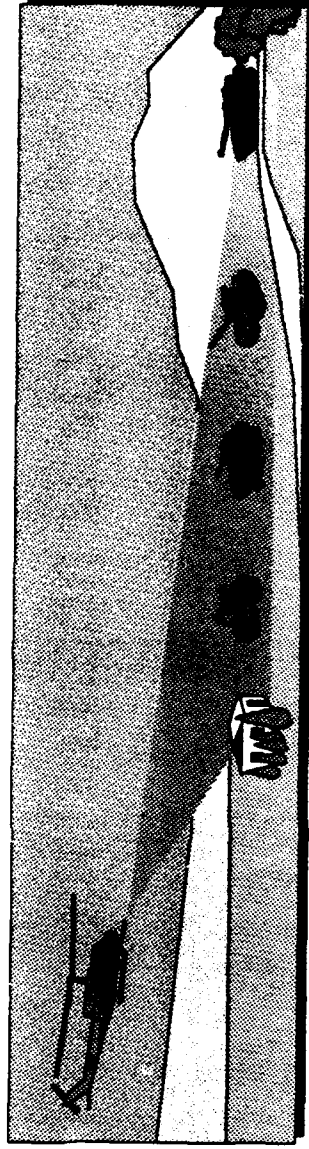
PROVIDE INDEPENDENT ANALYSIS AND ASSESSMENTS OF POTENTIAL CAPABILITIES OF VARIOUS TYPES OF SENSORS

- MMW/PASSIVE MMW
- LADAR
- INFRARED
- ACOUSTIC
- MULTI-MODE/DUAL MODE



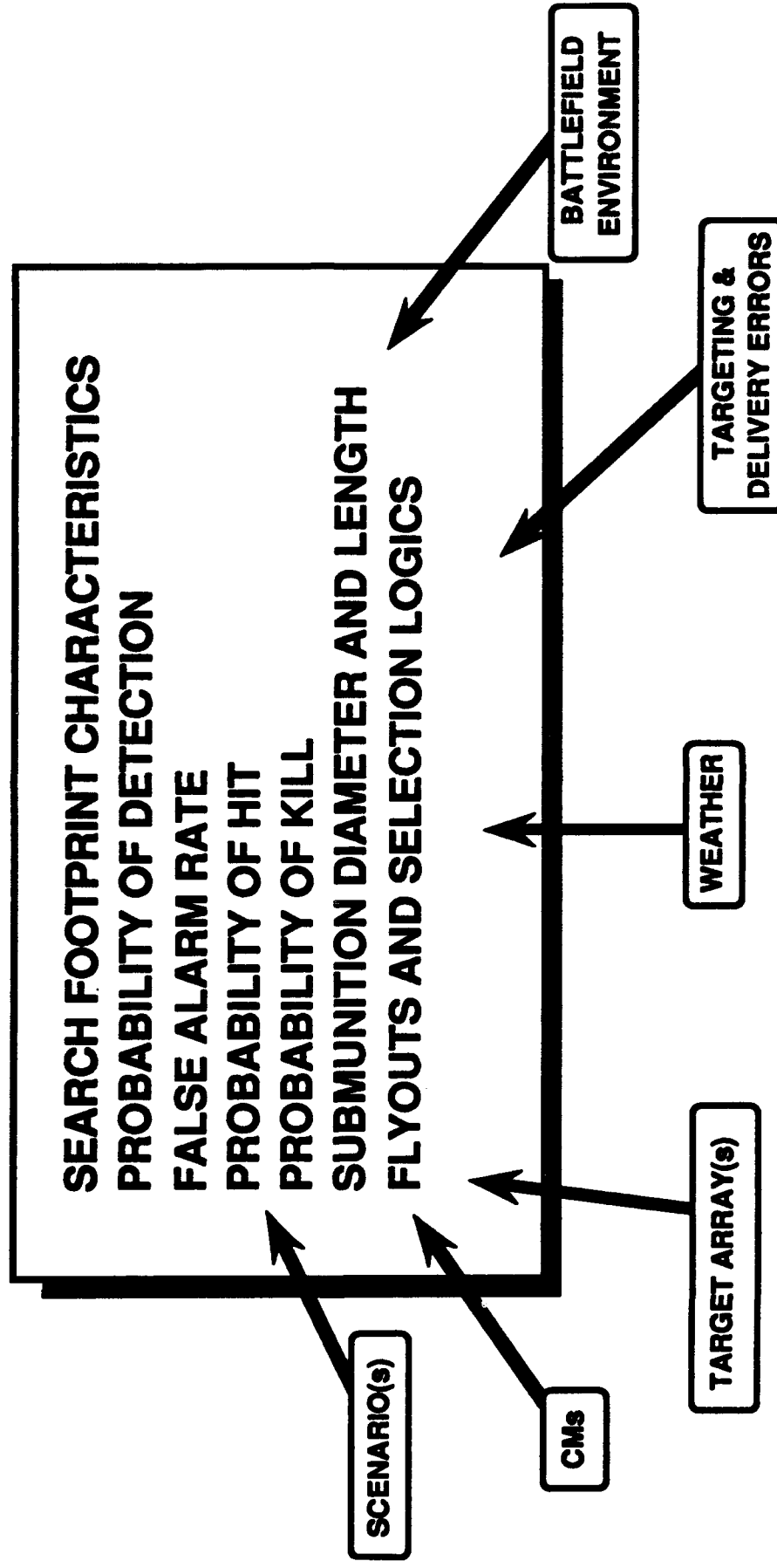
ACTIVITIES:

- ASSIST IN TOWER AND CAPTIVE FLIGHT TEST PLANNING
- PERFORM ASSESSMENT OF SENSORS' PERFORMANCE IN FIELD TESTS (TOWER AND CAPTIVE FLIGHT TEST MANEUVERS)
- PERFORM HARDWARE AND ALGORITHM DESIGN ASSESSMENTS
- IDENTIFY STRENGTHS / WEAKNESSES OF THE SENSORS' DESIGNS

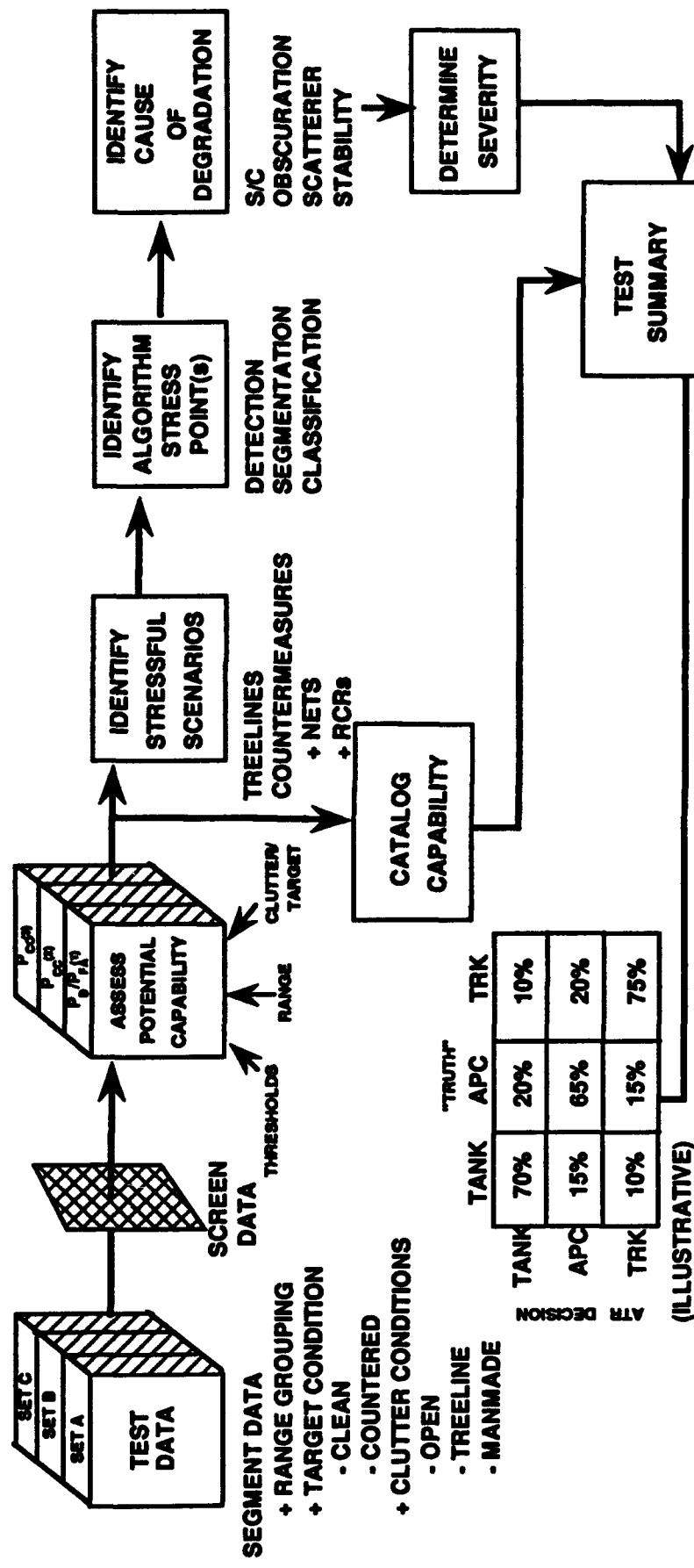


Presented By: **GACIAC**
DR. R. J. HEASTON

FACTORS AFFECTING SEEKER / SENSOR PERFORMANCE

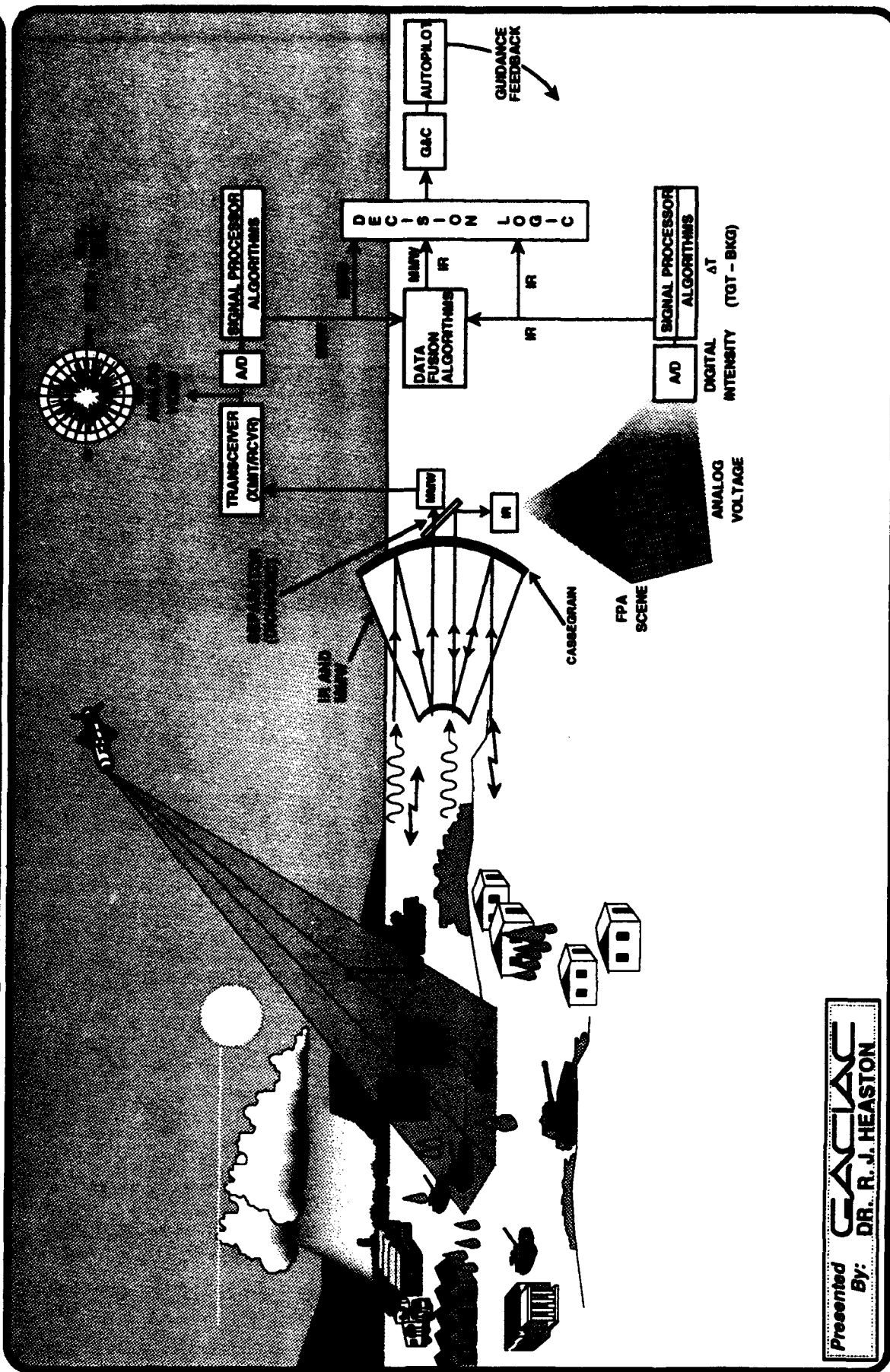


CAPABILITY ASSESSMENT METHODOLOGY



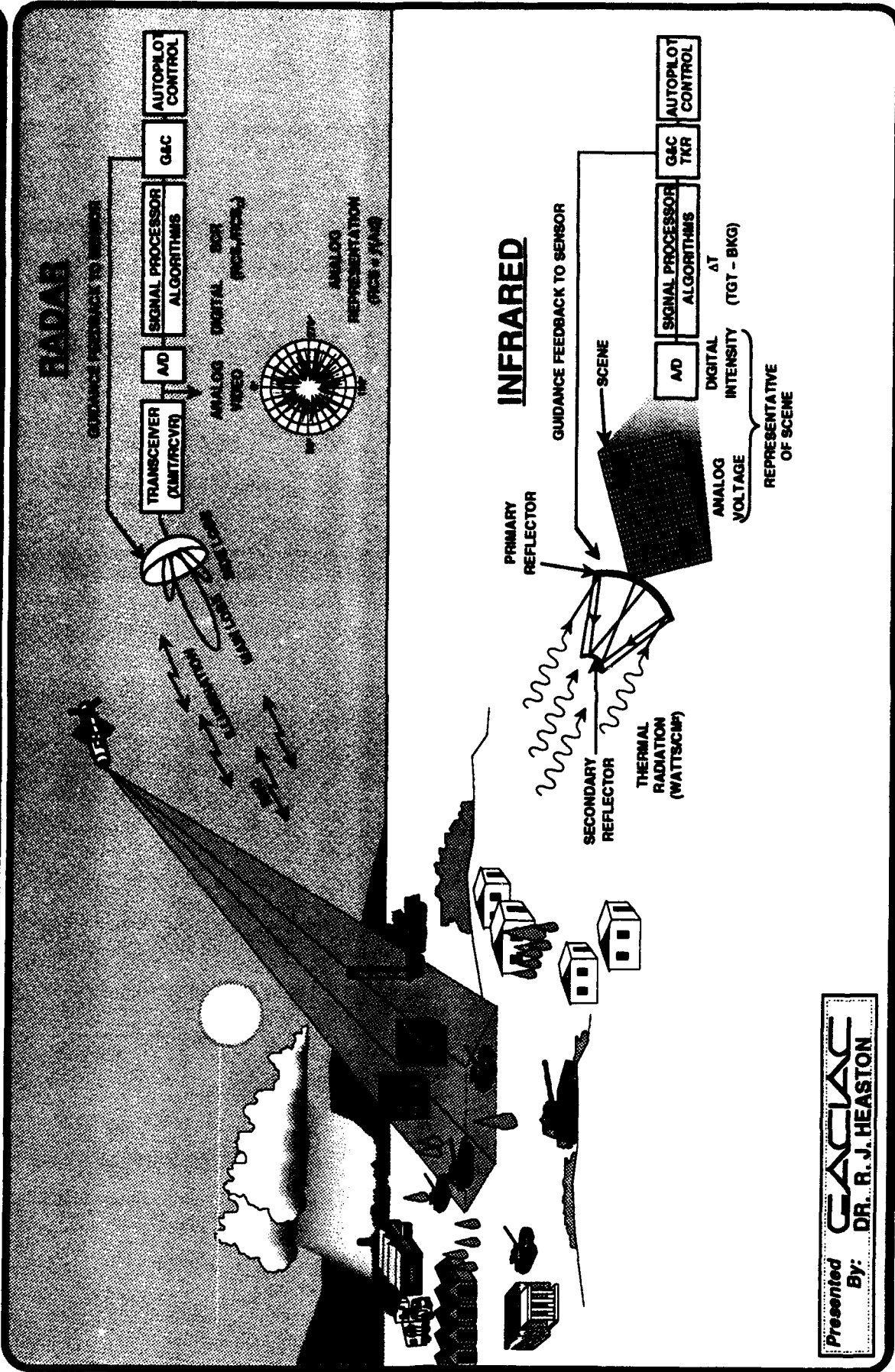
- (1) PROBABILITY OF DETECTION OF GROUND TRUTHED TARGETS & PROBABILITY OF FALSE ALARM FOR CMA/CLUTTER
- (2) PROBABILITY OF CORRECT CLASSIFICATION
- (3) PROBABILITY OF CORRECT TARGET ORIENTATION - WITHIN DEFINED TOLERANCE (AS APPLICABLE)

DUAL MODE REPRESENTATION



Presented By: **GACIAC**
DR. R. J. HEASTON

RADAR AND INFRARED REPRESENTATION

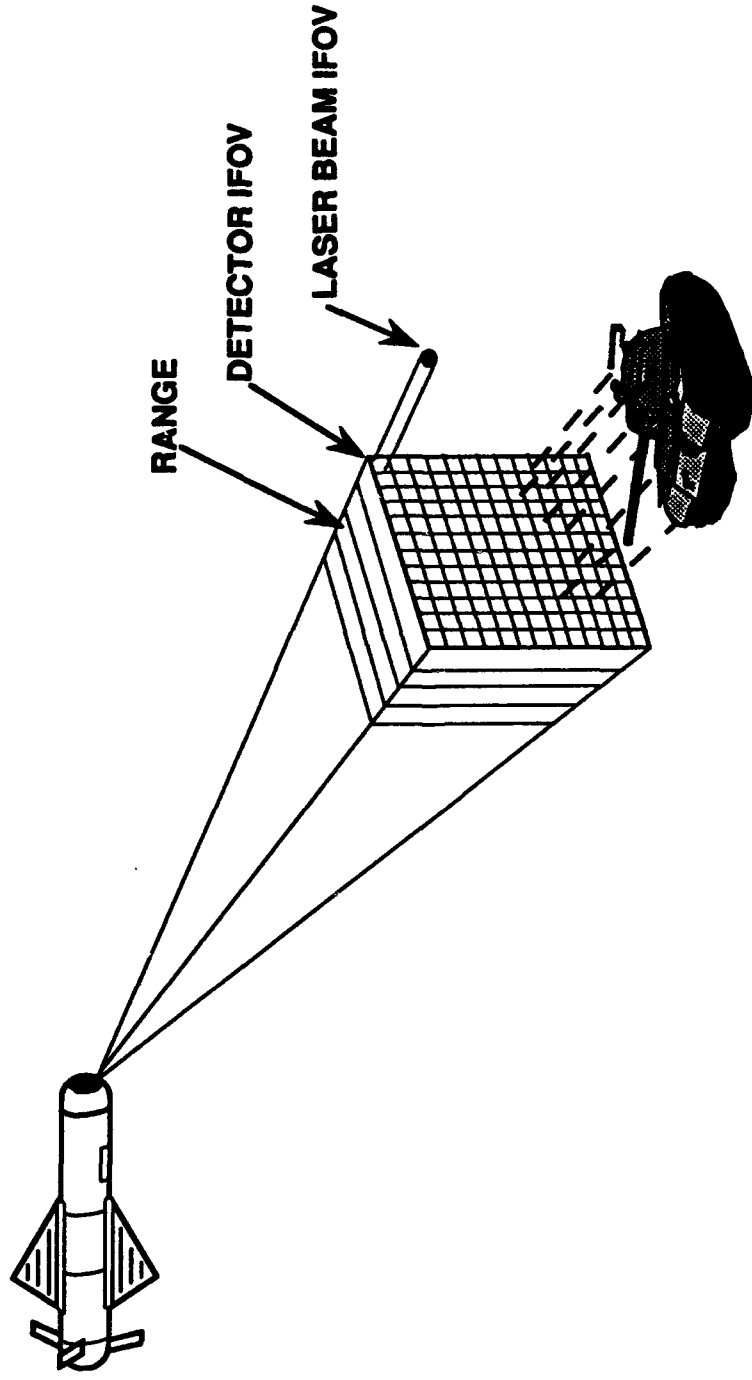


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DR. R. J. HEASTON

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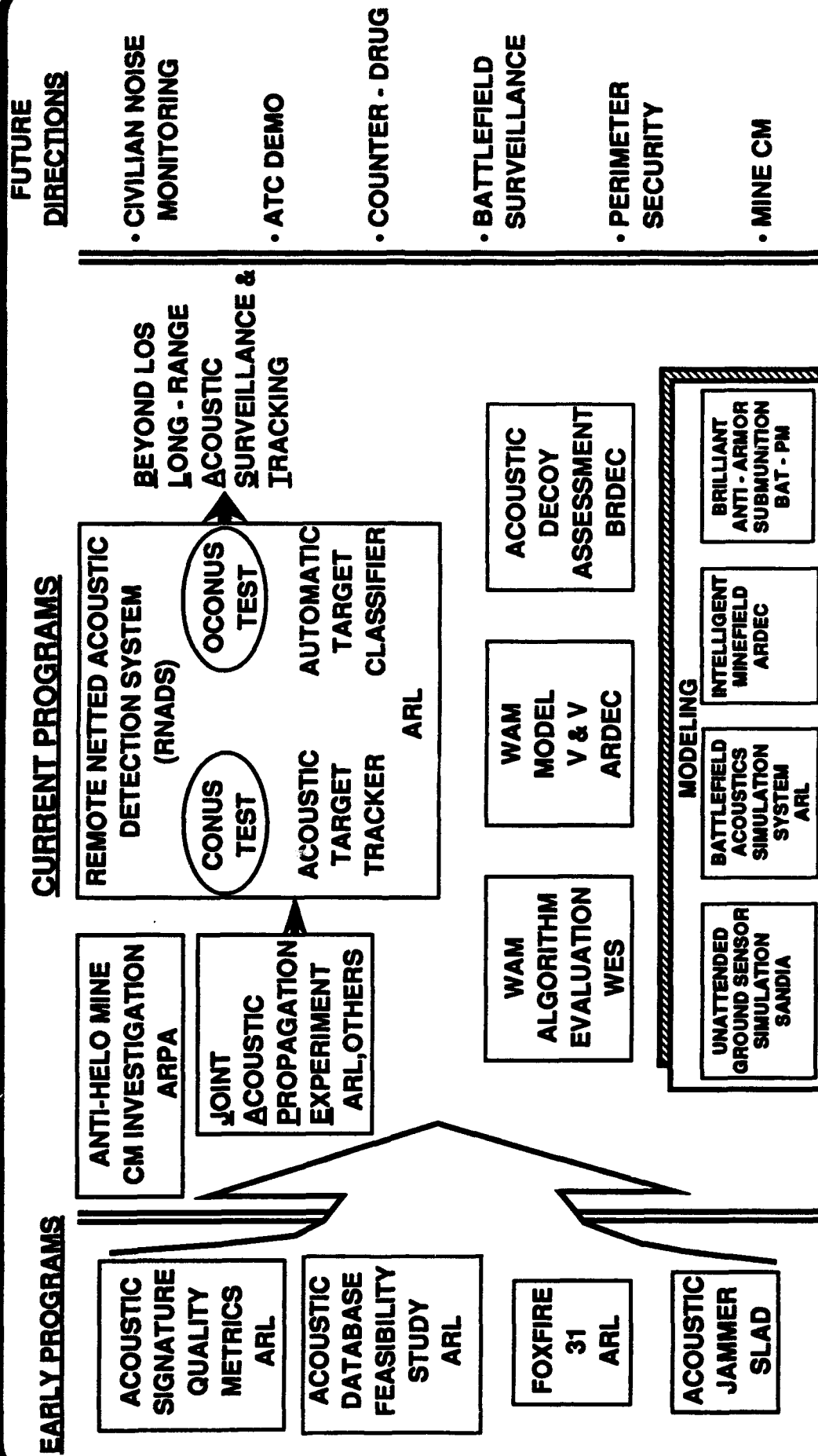
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LADAR TARGET SIGNATURE



- LADAR SYSTEMATICALLY MEASURES RANGE TO PIXELS ON REFLECTING SURFACES
- LADAR PROVIDES HIGH RESOLUTION IN RANGE AND ANGLE (AZIMUTH AND ELEVATION)
- RESULT IS HIGH RESOLUTION 3-4 IMAGERY

ACOUSTIC RESEARCH PROJECTS



MULTIPLE SENSOR SUITES

- SEEKERS REQUIRE AN ARCHITECTURE TO EMPLOY THE OUTPUTS OF MORE THAN ONE SENSOR
- SEQUENTIAL OPERATION (HANDOVER) -- TAKES ADVANTAGE OF COMPLEMENTARY SENSOR CHARACTERISTICS; i.e., ACQUISITION RANGE VERSUS TRACKING ACCURACY
- SIMULTANEOUS OPERATION -- PROVIDE ADDITIONAL MARGIN OF PERFORMANCE ENHANCEMENT TO ACQUIRE AND TRACK CHALLENGING TARGETS; i.e.. LOW OBSERVABLES, HIGH VALUE AND COLD STATIONARY TARGETS



SUMMARY PRODUCTS / VALUE

- **GACIAC HAS CONSIDERABLE EXPERIENCE IN STATE-OF-THE-ART SENSOR/SEEKER ANALYSIS**
 - VARIOUS SENSOR/SEEKER TECHNOLOGIES
 - SIGNAL PROCESSING TECHNIQUES/ALGORITHMS
 - TEST & EVALUATION
 - TARGET SIGNATURES
- **GACIAC PROVIDES TECHNOLOGY ASSESSMENTS, TECHNICAL REPORTS, SOTA REVIEWS, ETC.**
- **GACIAC SUPPORTS A VARIETY OF DoD CUSTOMERS AT VARIOUS LEVELS**





SENSORS AND ELECTRONIC DEVICES: MULTISPECTRAL DETECTION

Presented by:

Rodney C. Anderson

Director

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MULTISPECTRAL DETECTION: CONTEXT

- **CAMOUFLAGED AND CONCEALED TARGETS ARE OFTEN DIFFICULT TO DETECT USING CONVENTIONAL SENSOR DUE TO LOW CONTRAST AND HIGH THERMAL NOISE**
- **REQUIREMENTS FOR RAPID SEARCH AND DETECTION HAVE INCREASED (E.G., SEARCHING FOR SCUDS DURING THE GULF WAR)**
- **BACKGROUND AND TARGETS HAVE SPECTRAL FEATURES WHICH ARE SUBJECT TO EXPLOITATION TO ENHANCE DETECTION**
- **SEVERAL MISSIONS SUPPORTED:**
 - **Tactical Sea-based Air Forces**
 - o **Reconnaissance**
 - o **Deep strike**
 - **Naval Surface**
 - o **Naval shore bombardment**
 - o **Amphibious forces support**

MULTISPECTRAL DETECTION TASK

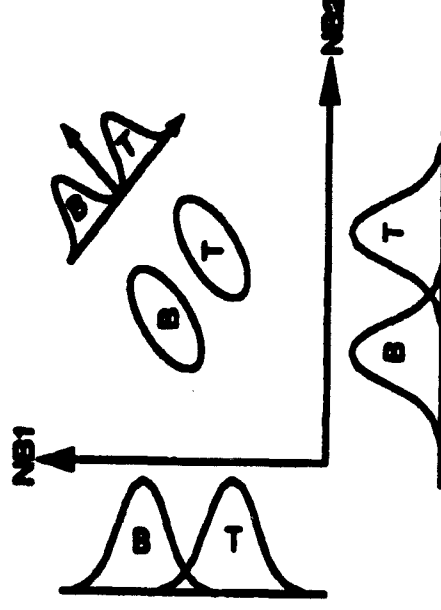
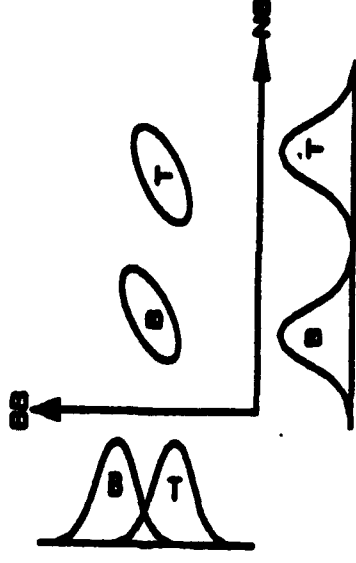
- **IMPLEMENTATION OF SENSOR KEY TECHNOLOGY (PASSIVE ELECTRO-OPTICAL SENSING)**
- **TASK FOCUS**
 - Evaluate fundamental phenomenology and mathematical basis of multispectral sensing
 - Sponsor: Naval Research Laboratory
 - Products consisted of reports, briefings, data, and analysis

METHODOLOGY

- **ISSUES**
 - Evaluate spectral properties
 - o Backgrounds
 - o Targets (paints)
 - Develop foundation for MLR multispectral detection
- **APPROACH**
 - Use existing data for initial evaluation
 - o IR Handbook, Handbook of Spectral Data...
 - o Spectral reflectance data
 - o Measured data (Fourier Transform spectroscopy)
 - Extend existing models to multispectral domain
 - o "Flat plate" radiance model
 - o Vegetative canopy model
 - Use temperature projection to remove thermal noise

TASK SUMMARY

- DATA EVALUATION
 - Spectral features exist in the thermal infrared
 - Identified fundamental physical processes that contribute to spectral structure
- DEVELOPED BASIS OF TEMPERATURE PROJECTION ON GENERALIZED MAXIMUM LIKELIHOOD RATIO TEST



TASK RESULTS

- **MULTISPECTRAL TECHNIQUES CAN THEORETICALLY INCREASE SIGNAL TO CLUTTER GAIN BY ORDERS OF MAGNITUDE**
- **ADDITIONAL HIGH RESOLUTION DATA FOR SPECIFIC SCENARIOS ARE REQUIRED**
- **REQUIREMENTS FOR ADDITIONAL DATA ACQUISITIONS DEVELOPED**

CONSEQUENCES

- **MULTISPECTRAL SENSING MAY YIELD GREATLY INCREASED DETECTION PERFORMANCE UNDER SOME CIRCUMSTANCES**
- **SMALLER (CHEAPER) MULTISPECTRAL SENSOR POSSIBLE SUBSTITUTE FOR EQUIVALENT NON-SPECTRAL SENSOR**
- **MULTISPECTRAL HAS POTENTIAL TO DETECT TARGET NOT DETECTABLE BY ANY OTHER MEANS**

TASK RELEVANCE

- **MULTISPECTRAL TECHNOLOGY RELEVANT TO:**
 - Environmental awareness
 - Trafficability analysis
 - Geologic exploration
 - Agricultural surveys
- **TASK METHODOLOGY RELEVANT TO:**
 - General automated passive remote sensing problem
 - Automated machine vision
 - Airborne/ ground based passive IR sensing

GENERIC SENSOR PACKAGE S&T ASSESSMENT FOR THE OFFICE OF NAVAL RESEARCH

Prepared by

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[The final report for this study is Limited Distribution and/or Classified.]

CONTEXT

- SUPPORT TO DoD S&T THRUST 2: PRECISION STRIKE, S&T THRUST 3: AIR SUPERIORITY AND DEFENSE, S&T THRUST 4: SEA CONTROL, AND S&T THRUST 5: ADVANCED LAND COMBAT
- RELEVANT TO DoD KEY TECHNOLOGY 3: SENSORS
- DoD MILITARY MISSIONS/FUNCTIONS: GROUND FORCES/CLOSE AIR SUPPORT, TACTICAL LAND-BASED AIR FORCES, TACTICAL SEA-BASED AIR FORCES
- THE PURPOSE OF THIS EFFORT WAS TO CREATE A POINT PAPER FOR ONR TO BE REVIEWED BY NAVAIR, AND THE ENTITIES WHICH ADDRESSED THE POTENTIAL FOR A GENERIC SENSOR PACKAGE WHICH COULD BE UTILIZED IN CURRENT AND FUTURE NAVAL AIRFRAMES (S3, P3, F/A-18, F-14, ANY NGW START)

Prepared by: J. McCasland-Battelle/
L. W. Williams-TWSTIAC

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CONTEXT (Continued)

- THE INPUT FOR THIS OVERALL EFFORT CAME FROM TWO MAJOR SOURCES (1) EXTERNAL TO THE GOVERNMENT (INDUSTRY) AND (2) INTERNAL TO THE GOVERNMENT (LARS, NAWC, WPAFB, ARDA, ETC.)
- INDUSTRY RESPONSE WAS SOLICITED IN THE TRADITIONAL CBD APPROACH
- TWSTIAC WAS TASKED TO SUPPORT THE INTERNAL RESPONSE

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TWSTIAC TASK

- **THE KIND OF INSIGHTS SOUGHT BY ONR IN THIS EFFORT WOULD HELP ADDRESS/ANSWER QUESTIONS SUCH AS:**
 - (1) With the threats/targets/environment currently envisioned are there current on-going sensor developments that should be singled out and pushed (fully funded), which would result in a very significant improvement that would translate to much higher leverage on the battlefield?**
 - (2) Given the status of current developments, what would be the results of waiting 5 years as technology progressed and then providing funding for Engineering & Manufacturing Development to achieve high leverage in (1) above?**
 - (3) Same as (2), but delay 10 years**
- **SENSOR DEVELOPMENTS ADDRESSED TO INCLUDE ALL SERVICES AND ALL SENSOR AREAS (ACQUISITION, STRIKE, ETC.)**

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TWSTIAC TASK

(Continued)

- **HELP IDENTIFY THOSE SENSOR DEVELOPMENTS THAT NOT ONLY SHOW PROMISE BUT ALSO THOSE EFFORTS THAT WOULD SHOW PROMISE IF BETTER PROGRAM INTEGRATION WERE EXERCISED**

**Prepared by: J. McCasland-Battelle/
L. W. Williams-TWSTIAC**

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TWSTIAC METHODOLOGY

- DATA COLLECTION

- Data collection for sensor S&T assessments consisted of visits to Government labs/offices and documentation review. The two prime sources in each area are:

- Visits: NAWC Warminster
- Documents: Fiscal year 1994 (FY 94) Joint Service Program Plan Technology Panel for Sensors (JDL-TDSE)

- DATA ANALYSIS

- Sensor development project efforts were reviewed and assessed by TWSTIAC experts in each area of endeavor (radar, IR, laser, Etc.) providing their perspectives and insights

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TWSTIAC METHODOLOGY

(Continued)

- **DATA SYNTHESIS**

- Armed with the viewpoint/perspectives of the results of the data analysis a review of the goals/priorities/schedule in a project related to similar efforts as well as efforts that used a different technology or different approach but were trying to achieve the same end results. Program integration between services relative to each service's project priorities was a big factor in the synthesis

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APPROACH

- **EARLY IN THIS EFFORT IT WAS EVIDENT THAT THE FUTURE WORLD IN WHICH WE MIGHT HAVE TO CONDUCT BATTLEFIELD OPS HAD TO BE NARROWED TO A TARGET MATRIX THAT WAS REPRESENTATIVE BUT NOT SO BIG THAT THE STUDY WOULD GET BOGGED DOWN.**
- **THE MAIN SOURCES OF INFORMATION WERE AS DESCRIBED ABOVE**
- **THE "NEW" INFORMATION THAT RESULTED FROM THIS ASSESSMENT WAS THE IDENTIFICATION OF THOSE SENSOR DEVELOPMENTS EFFORTS THAT HAD "BREAK- THROUGH POTENTIAL" RELATIVE ACHIEVING HIGH BATTLEFIELD LEVERAGE AGAINST THE THREAT MATRIX MENTIONED ABOVE.**

Prepared by: J. McCasland-Battelle/
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SUMMARY OF DATA

- **FOURTEEN CATEGORIES OF SENSOR DEVELOPMENTS WERE ADDRESSED IN THE FOLLOWING SUBAREAS:**

- **Airborne Wide Area Surveillance (WAS) Radar (ZANF)**
- **OTH Land Based Radar**
- **Wide-Area Surveillance Electro-Optic(EO)**
- **Air-Air/Air-Surface Radar**
- **Strike Radar (ZANF)**
- **Nap-of-Earth Radar**
- **Anti-Submarine Warfare**
- **Surface-Surface, Surface-to-Air Radar (Sea Based)**
- **Air-Air and Air-Surface Electro-Optics**
- **Anti-Surface Electro-Optics (ZANF) (Joint)**
- **Anti-Surface Electro-Optics (Individual Services)**
- **Surface-Surface/Surface-Air Electro-Optics (Sea Based)**
- **Automatic Target Recognition (ATR) Technology**
- **JDL Multi-Color IR Technology Working Group**

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SUMMARY OF DATA

(Continued)

- **IN SOME CASES WHOLE CATEGORIES DID NOT CONTAIN DEVELOPMENTS ORIENTED TO THE GENERIC SENSOR PACKAGE THREAT MATRIX (TELS, TBMS, VLO TGTS) SUCH AS ANTI-SUBMARINE WARFARE**
- **ALL WERE ASSESSED FOR AIR PLATFORM CARRIAGE**
- **OUT OF THE ABOVE A TOTAL OF 62 SPECIFIC DEVELOPMENTS OR GROUPINGS OF DEVELOPMENTS HAD POTENTIAL FOR PROVIDING A DIRECT OR INDIRECT POSITIVE INFLUENCE**

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RESULTS OF DATA ANALYSIS

- THE SENSOR DEVELOPMENT PROGRAM/PROJECT ENDEAVORS WERE ASSESSED WITH RESPECT TO THEIR "BREAK-THROUGH POTENTIAL" RELATIVE TO PRODUCING THE KIND OF PERFORMANCE IMPROVEMENTS THAT COULD RESULT IN THE BATTLEFIELD LEVERAGE PREVIOUSLY MENTIONED
- SOME OF THESE EFFORTS WERE NOT CLEAR-CUT BLACK/WHITE DECISIONS. FOR EXAMPLE SOME EFFORTS THAT WERE EVALUATED AS HIGH AGAINST VLO AIR TARGETS WERE EVALUATED AS LOW AGAINST THE REST OF THE THREATS (TBMS, TELS). ALSO SOME EFFORTS EXHIBITED GOOD (HIGH) ATTRIBUTES FOR ONE PARTICULAR FACTOR SUCH AS SENSOR-TO-SENSOR KEYING BUT FELL DOWN IN OTHER AREAS. THE "BREAK-THROUGH POTENTIAL" THAT THESE EFFORTS WERE ASSIGNED WAS BASED ON THEIR POTENTIAL TO CONTRIBUTE TO THE ENTIRE THREAT MATRIX

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RESULTS OF DATA ANALYSIS (Continued)

- THE SIXTY-TWO (62) EFFORTS ASSESSED WERE EVALUATED AS FOLLOWS

Break-through Potential
Assessment Rating

Number

High	14
Moderate-high	16
Moderate	4
Low-moderate	10
Low	18

- FOR EACH DEVELOPMENT EFFORT THE GOAL/OBJECTIVE AND TIME FRAME FOR COMPLETION WAS STATED

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CONSEQUENCES

- **FULL IMPACT OF THIS EFFORT WILL NOT BE CLEARLY EVIDENT UNTIL ONR'S INTERNAL ASSESSMENT CAN BE ADDRESSED IN CONTEXT WITH THE INDUSTRIAL RESPONSE**
- **BENEFITS TO DOD WILL COME IN THE VISIBILITY TO ADDRESS AND PROVIDE PROGRAM INTEGRATION WHERE IT IS NEEDED TO MAKE THINGS HAPPEN**
- **THE ABOVE WILL IN TURN PROVIDE THE COST SAVINGS TO NAVAIR IN TERMS OF IDENTIFYING THE MOST EFFECTIVE TECHNOLOGY INFUSION PROGRAMS TO PURSUE**
- **ACCELERATION AND SUCCESSFUL COMPLETION OF PROGRAM MILESTONES**
- **REVIEW OF OPERATIONS PURSUANT TO SENSOR CAPABILITIES EXISTENT ON A LARGER VARIETY OF AIRFRAMES/PLATFORMS**

RELEVANCE TO OTHER USERS

- **AS "NEW START" PROGRAMS BECOME FEWER AND HARDER TO IMPLEMENT, THIS TYPE OF EXERCISE WILL BE IMPORTANT ACROSS ALL DOD SERVICES AND WEAPON SYSTEMS**
- **THIS TYPE OF ENDEAVOR HIGHLIGHTS WHERE "PROGRAM INTEGRATION" IS NEEDED IN ADDITION TO ADDRESSING THE TECHNICAL MERITS OF A PARTICULAR DEVELOPMENT**

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ASSESSMENT OF ULTRA-WIDEBAND (UWB) RADAR TECHNOLOGY

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CONTEXT

- **DoD S&T THRUSTS 1: GLOBAL SURVEILLANCE AND COMMUNICATIONS, 2: PRECISION STRIKE, AND 3: AIR SUPERIORITY AND DEFENSE**
- **DoD KEY TECHNOLOGIES: SENSORS/RADAR SENSOR TECHNOLOGY**
- **DoD MILITARY MISSIONS/FUNCTIONS: STRATEGIC FORCES, AIR DEFENSE**

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TWSTIAC TASK/BASIC INFORMATION PRODUCT

TWSTIAC WAS ASKED TO:

- **EXAMINE THE STATE OF THE ART AND POTENTIAL BENEFITS OF UWB TECHNOLOGY, PARTICULARLY FOR RADAR APPLICATIONS**
- **IDENTIFY AND PRIORITIZE RESEARCH TO BE PURSUED**

Prepared by: V. G. Puglielli-Battelle/
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TWSTIAC METHODOLOGY

- **BLUE RIBBON PANEL OF RESIDENT AND NATIONAL EXPERTS ON UWB TECHNOLOGY AND RADAR**
- **REVIEWED PRIOR UWB RADAR DEVELOPMENT**
 - **Experimental data**
 - **Literature--including Soviet**
- **REVIEWED ONGOING AND PROPOSED WORK**
 - **Government laboratories**
 - **Industry and academia**
- **DETERMINED POTENTIAL PERFORMANCE BENEFITS**
 - **Radar technologies, including against low-observable targets**
 - **Countermeasures, especially probability of detection**

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L. W. Williams-TWSTIAC

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TWSTIAC METHODOLOGY (Continued)

- **IDENTIFIED TECHNOLOGY ISSUES/GAPS IN KNOWLEDGE/
PRIORITY OF IMPORTANCE**
- **RECOMMENDED NEEDED RESEARCH**
 - **Areas for further investigation**
 - **Experimental tools/hardware needed**
- **DETERMINED POSSIBLE APPLICATIONS**

Prepared by: V. G. Puglielli-Battelle/
L. W. Williams-TWSTIAC

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ASSISTANCE DELIVERED

- **CONCENTRATED ON CHARACTERISTICS OF AND CLAIMS MADE FOR UWB TECHNOLOGY: RADAR, COMMUNICATIONS, ELECTRONIC WARFARE AND RF WEAPONIZATION**
 - **No applications were advanced for communications**
 - **Government in-house committee was addressing applications to EW and RF weaponization**
 - **Therefore, this study concentrated on radar applications**
- **FOCUSED ON CLAIMS FOR ULTRA-WIDEBAND "IMPULSE" RADAR AS BEING INHERENTLY:**
 - **Counter-stealth (i.e., to defeat the F-117 and the B-2)**
 - **Low Probability of Intercept (LPI) (to defeat countermeasures)**
 - **Capable of detecting relocatable targets in camouflage/foilage**
- **REVIEWED THE THEORETICAL BASES FOR CLAIMED CAPABILITIES**

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RESULTS OF DATA ANALYSIS

- **IMPULSE RADAR IS NOT INHERENTLY COUNTER-STEALTH**
 - **Conventional radars are able to exploit any vulnerabilities resulting from target shaping**
 - **No effects in RAM are unique to impulse radar**
- **IMPULSE RADAR IS NOT INHERENTLY DIFFICULT TO DETECT**
 - **It is difficult to make any radar hard to detect**
 - **Impulse radar has no special LPI characteristics, is readily detected by an appropriately designed intercept receiver**
- **A PROPERLY DESIGNED IMPULSE RADAR MIGHT BE ABLE TO DETECT TARGETS SHIELDED BEHIND TREES (AS MIGHT ANY NON-IMPULSE UWB RADAR)**

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RESULTS (Continued)

- **ADVANCES IN SOURCES FOR VERY HIGH POWER SHORT PULSES MIGHT BENEFIT CONVENTIONAL SHORT PULSE RADAR AS WELL AS IMPULSE TRANSMITTERS**
- **CONVENTIONAL RADAR THEORY IS COMPLETELY ADEQUATE FOR UNDERSTANDING IMPULSE RADAR PHENOMENA--THERE IS NO UNIQUE THEORETICAL BASIS FOR UWB RADAR**
- **RECOMMENDATIONS WERE MADE:**
 - **Do analyses of point designs using both impulse and non-impulse radar approaches for four military applications**
 - **Do studies of clutter behavior of UWB radar systems and characteristics of UWB antennas**
 - **Do a modest study to document characteristics of self-induced transparency and other non-linear effects possibly relevant to military systems**

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CONCLUSIONS

- **INTERESTING WORK WAS UNDER WAY, AND SELECTED/LIMITED R&D INVESTMENTS COULD EXPLORE ITS POTENTIAL BENEFITS**
- **IMPULSE RADAR DOES NOT OFFER A MAJOR NEW MILITARY CAPABILITY, NOR DOES IT THREATEN A SERIOUS TECHNOLOGICAL SURPRISE**

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CONSEQUENCES

- WHAT HAS HAPPENED AS A RESULT OF THIS EFFORT?

- Financial benefits to DoD

- Congress had mandated \$25M FY90 funds be spent on this technology. This effort helped to focus investment of \$10M FY90-91 and \$12M FY92-93 funding for UWB into theoretically sound, technologically promising, and operationally appropriate R&D
- Avoided "Loss Leader" construction of an unnecessary UWB radar site-- future investments could have been multiples of \$25M

- Other benefits to DoD

- Disproved unfounded challenges against the viability of stealth technologies
- Discredited claims that the U.S. was at risk of major technological surprise
- Brought some discipline and technical foundation to a highly visible, poorly described technology as an aid to decision makers
- Laid the foundation for subsequent technology developments which are significant for several applications, the most notable proving to be foliage penetration radar.

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RELEVANCE TO OTHER USERS

- **THE METHODOLOGY OF A "BLUE RIBBON" TEAM OF HIGH QUALITY/INTEGRITY UNDER IMPARTIAL ORGANIZATIONAL LEADERSHIP CAN BE APPLIED TO ANY PROBLEM WHERE TECHNICAL CONFUSION IS WIDESPREAD AND UNUSUAL CLAIMS MAY BE THE BASIS FOR DoD INVESTMENT**
- **THE REPORT STANDS AS A SOUND GUIDE FOR FUTURE PLANNERS IN THIS TECHNOLOGY. THE BASIC PHYSICS WHICH FORMS THE REPORT'S FOUNDATION WILL NOT CHANGE WITH TIME. THE TECHNOLOGY CONTINUES TO ADVANCE ALONG THE LINES PREDICTED.**

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AIR SUPERIORITY AND DEFENSE



LITERATURE SEARCHES: A SERIES OF CPIA CORE PRODUCTS DIRECTED TO THE DoD THRUST ON AIR SUPERIORITY

Prepared by

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CPIA CORE TECHNICAL PRODUCTS

- LITERATURE SEARCHES
- CHEMICAL PROPULSION TECHNOLOGY REVIEWS
- PROPULSION MANUALS
- CHEMICAL PROPULSION ABSTRACTS
- NEWSLETTER
- TECHNOLOGY BRIEFINGS
- CONTRACTS LIST
- ACRONYMS LIST
- JANNAF TECHNICAL MEETING AND WORKSHOP PROCEEDINGS

Prepared by: T. W. Christian

CPIA-2

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AIR SUPERIORITY LITERATURE SEARCHES

GFY 1991-1993

- LS91-07 Liquid Ramjet Fuels
- LS 1-13 Pulse Motor Technology
- LS92-01 Class 1.3 Minimum Smoke Propellants
- LS92-02 High Density Solid rocket Propellants
- LS92-07 Laser Ignition
- LS92-08 Low Cost Propulsion Systems
- LS92-14 New Propellant Development
- LS92-18 High Burn Rate Propellants
- LS92-20 Gap Polymer and Propellants
- LS93-01 Supersonic Combustion Ramjets
- LS93-09 Signature Reduction of Tactical System
- LS93-17 Tactical Missile Thrust Vector Control



CONTEXT

- BROAD OBJECTIVE OF THE DoD THRUST ON AIR SUPERIORITY AND DEFENSE
 - 100% increase in the no-escape zone for AAMs (Re: DoD Key Technologies Plan)
- SUBSET OF THE DoD THRUST ON AIR SUPERIORITY AND DEFENSE
 - Develop and Demonstrate Pulse Motor that use Aero/TVC controls (Ref: ODDR&E Aerospace Propulsion and Power Science and Technology Review)
- MILITARY PAYOFFS
 - Increased Range
 - Increased Maneuverability
 - Improved End-Game Maneuverability
 - Reduced Missile Size



BASIC CPIA INFORMATION PRODUCT

- CPIA TASK/INFORMATION PRODUCT FOCUS
 - Task
 - Review and summarize the technologies applied to highly maneuverable pulse motors
 - Requesters
 - U.S. Navy and the industrial propulsion community
 - Form
 - Prepared two literature searches on pulse motor technology (LS 91-13) and on tactical missile TVC (LS 93-17)

Prepared by: T. W. Christian

CPIA-5

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CPIA METHODOLOGY

- METHODOLOGY USED TO PERFORM WORK
 - Data Collection
 - Searched our Propulsion Information Retrieval System (PIRS) for the most relevant report/paper citations
 - Data Analysis
 - Collected the best documents that related to pulse motors and tactical missile TVC systems
- APPROACH
 - Uniqueness
 - Selecting the very best technical reports and papers addressing the technology issues based on knowledge and expertise gained in other CPIA efforts
 - Existing information CPIA used:
 - Technical reports and papers contained in CPIA's 75,000 document library

Prepared by: T. W. Christian

CPIA-6

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SUMMARY OF DATA

- DATA COLLECTED

- Data and information collected during the performance of this task
 - New wafer igniters, combustion barriers, multiple igniter systems, high temperature ceramic materials for jet tabs
- Interesting characteristics common to the data
 - Technologies developed in the 60s can be applied to 1993 pulse motors

Prepared by: T. W. Christian

CPIA-7

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RESULTS OF DATA ANALYSIS

- FINDINGS RESULTING FROM THE ANALYSIS OF DATA COLLECTED BY CPIA
 - Pulse motors offer an alternative to air breathers for outer air battle missions

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CONSEQUENCES

- RESULT OF PRODUCING THESE SERIES OF LITERATURE SEARCHES
 - Values/Benefits
 - Over the past three years, over 64 government and industrial organizations have subscribed to these products at a cost of approximately \$9,000/y
 - The references and papers permit propulsion engineers immediate access to summaries of current propulsion technology findings

Prepared by: T. W. Christian

CPIA-9

DLB 10/93

**AIR SUPERIORITY AND GLOBAL SURVEILLANCE:
SHIPBOARD INFRARED SEARCH AND TRACK
SENSORS**

Presented by:

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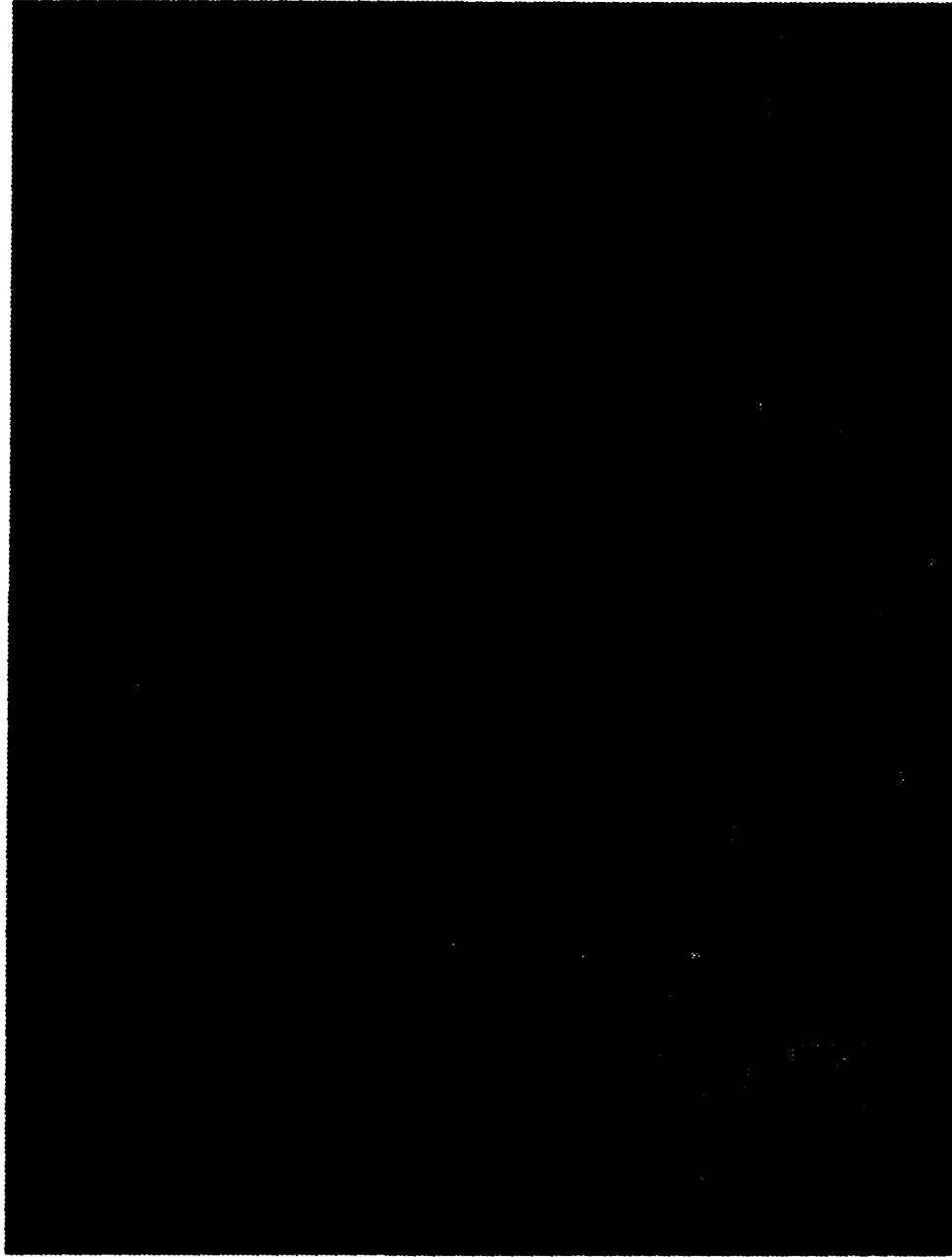
SHIPBOARD INFRARED SEARCH AND TRACK SENSOR TECHNOLOGY

- **Context:** High speed sea-skimming cruise missiles pose a severe threat to Navy ships, especially those operating in littoral environments
- **Objective:** Provide infrared data and models to support the development of a shipboard infrared search system technology base. This tech base will be used to support demonstration of a seagoing SIRST.
- **Technology area:** Sensors (passive electro-optical)
- **Thrusts supported:** Air superiority
- **Missions:** Naval surface
 - Power projection
 - Naval shore bombardment
 - Amphibious forces support
 - Sea control

SIRST TECHNICAL AREA TASK

- Support sensor development
- Several support methods
 - Use available handbook and data to calculate generic signature levels for generic targets. Handbook type data are appropriate for the level of approximation necessary for bounding the threat parameter space.
 - Use phenomenological models to provide insights into effects important toIRST processing. (chart from SIRST final report)
 - Incorporate other IAC models and data to generate threat profiles.
 - o Blue Max model (SURVIAC) used to generate flight path for incoming cruise missiles
 - o Guidance and control system algorithms used to evaluate cruise missile paths (GACIAC)
 - Used IRIA electronic file transfer capability to transfer up to date information

INFRARED OCEAN SCENE



Prepared by: R. Anderson

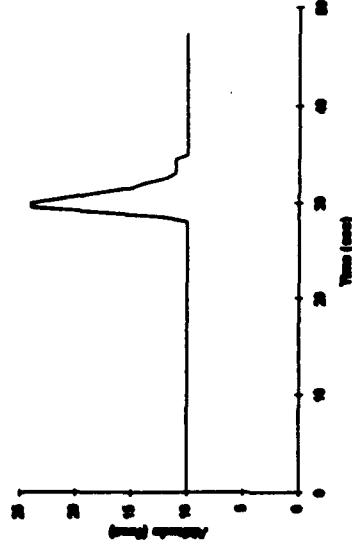
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Intercept



METHODOLOGY

- ISSUES
 - Vehicle reflectance properties influence signature
 - Atmospheric and background properties dominate performance
 - Vehicle maneuvers constrain signal processing approach
 - Missile guidance mode impacts processing requirements
- APPROACH
 - Use IRIA reflectance prediction code
 - Extract statistics from IRIA handbooks and databases
 - Use Blue Max code (SURVIAC) to predict flight path
 - Consult with guidance experts (GACIAC)



TASK SUMMARY

- **RESULTS**
 - Predicted dynamic signatures of generic targets
 - Quantified effects of target motion
 - Estimated sensor performance for several scenarios
- **TECHNICAL RECOMMENDATIONS**
 - Include higher order signature effects in modeling and prediction
 - Ground truth needed for assessment of atmospheric propagation
 - Algorithm development must be closely linked to phenomena

CONSEQUENCES

- **FINANCIAL BENEFIT**
 - Algorithm development plan improved
 - Focussed background data acquisition
- **PERFORMANCE BENEFITS**
 - Reduced development risk
 - Improved detection capability

TASK RELEVANCE

- **IRST TECHNOLOGY RELEVANT TO:**
 - **Situation awareness**
 - **Collision avoidance**
 - **Passive air traffic control**
 - **Counter low observables**
 - **Missile seeker development**
- **TASK METHODOLOGY RELEVANT TO:**
 - **General automated passive remote sensing problem**
 - **Automated machine vision**
 - **Airborne/ ground based passive IR sensing**

THE JOINT LIVE FIRE/LIVE FIRE TEST (JLFLFT) PROGRAM CATALOGUE

Prepared by

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Approved for Public Release: Distribution Unlimited

CONTEXT

- SUPPORT DOD TACTICAL LAND-BASED AIR FORCES AND GROUND FORCES WITHIN THE DOD S & T THRUST AREA OF AIR SUPERIORITY AND ADVANCED LAND COMBAT BY HELPING:
 - To Disseminate Critical Vulnerability/Lethality Data on U.S. and Foreign Air, Ground, and Sea Combat Systems
 - To Serve as a Compilation of Test Program Data and Reports

JOINT LIVE FIRE/LIVE FIRE TEST PROGRAM CATALOGUE

- **DOD S & T THRUST**
 - **Air Superiority, Advanced Land Combat**
- **SURVIAC TASK FOCUS**
 - **Identify and Verify All JLF/LFT Tests and Test Reports**
 - **Develop and Distribute Initial Catalogue**
 - **Update and Distribute Annual Revisions**

SURVIAC METHODOLOGY

- **METHODOLOGY USED TO PERFORM WORK**
 - **Reviews of JLF/LFT Test Plans**
 - **Interviews with JLF Test Planners**
 - **Searches for Published JLF/LFT Test Reports**
 - **Follow-Up Interviews with JLF/LFT Test Planners to Identify Unpublished Test Plans and Reports**
- **APPROACH**
 - **Apply First-Hand Knowledge of Information to be Included in the JLF/LFT Catalogue**
 - **Focus on Published JLF/LFT Test Plan Books, Reports, and Newsletter Articles**
 - **Use a Database to Compile and Organize All Information Obtained and for Rapid Access**

SUMMARY OF DATA

- **DATA COLLECTED**
 - **All Currently Available Data on JLF/LFT Programs**
- **DATA CHARACTERISTICS**
 - **Covers all Data Parameters Required by Analysts Within the JLF/LFT Community**
 - **Comprehensive Source of Air and Ground Ballistic Live Fire Test Data and Test Reports from Both the JLF and LFT Communities**

RESULTS OF DATA ANALYSIS

- **FINDINGS SYNTHESIZED BY SURVIAC**
 - **Allows the Test Community to Identify Tests that have Already Been Performed to Eliminate Duplicate or Redundant Tests**
 - **Provides a Comprehensive Source of Test Information that can be Used to Enhance or Verify Future Test Plans, Approaches, or Test Results**
 - **Only Lists JLF/LFT Test Information; Does Not Provide Advice/Recommendations**
- **SUMMARY OF TECHNICAL RECOMMENDATIONS**
 - **Continue to Update and Reissue the Catalogue as New Tests are Proposed and Current Tests are Completed**

CONSEQUENCES

- **WHAT HAS HAPPENED AS A RESULT OF COMPLETION OF THIS SURVIAC PRODUCT**
 - **Financial Benefits to DoD**
 - Avoids Duplication of Test Efforts
 - Provides a Source for Baseline Cost Estimates When Developing Similar Test Programs
 - Illustrates Test Plan Approaches to Address Varied Test Objectives
 - **Other Benefits to DoD**
 - Shows the Cost and Technical Variations Associated with Testing Actual Hardware, Mockups, and Replica Test Articles
 - Establishes a Model for Possible Transition to Civilian Aircraft Safety, Crash and Terrorist Bomb Incident Information
 - **Changes in DoD Operations, Plans, or Procedures as a Direct Result of Product**
 - More Efficient Live Fire Test Planning and Execution Process

RELEVANCE TO OTHER USERS

- **FEDERAL AVIATION ADMINISTRATION**
- **AUTOMOBILE MANUFACTURERS**
- **CIVILIAN AIRLINER MANUFACTURERS**

U.S. AIR FORCE SURFACE-TO-AIR ENGAGEMENTS DURING OPERATION DESERT STORM

Prepared by

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CONTEXT

- **SUPPORT TACTICAL LAND- AND SEA-BASED AIR FORCES
SURVIVABILITY DESIGNS ENHANCING AIR SUPERIORITY BY:**
 - **Collecting and Preserving Data on Surface-To-Air Threat
Weapon System Encounters that Occurred During
Operation Desert Storm**

U.S. AIR FORCE SURFACE-TO-AIR ENGAGEMENTS DURING OPERATION DESERT STORM

- **DOD S & T THRUST**
 - **Air Superiority**
- **SURVIAC TASK FOCUS**
 - **Collect and Analyze Data on Surface-To-Air Engagements from Operation Desert Storm**
 - **Preserve and Provide Data to be Used for Research by Military Services and Scientific Community**

SURVIAC METHODOLOGY

- **METHODOLOGY USED TO PERFORM WORK**
 - **Data Collected Under the COARP (Combat Operations Assessment and Reporting Program)**
 - **Data Reported in "Red Baron" Type Format**
 - **Data Stored in a DoD Classified Database**
- **APPROACH**
 - **Rapidly Instituted COARP Data Collection Approach to Respond to Desert Storm**
 - **Applied Technique Used in Southeast Asia Battle Damage Assessment and Reporting Program (BDARP)**
 - **Developed Standardized Source Document for Data Collection**
 - **Trained Teams to Conduct On-Site Data Collection Interviews**

SUMMARY OF DATA

- **DATA COLLECTED**

- **Combat Incident Data on All USAF Surface-To-Air
Threat Encounters During Desert Storm**
- **Operations Information**
- **Damage and Effects Data**
- **Maintenance Records**

RESULTS OF DATA ANALYSIS

- **FINDINGS SYNTHESIZED BY SURVIAC**
 - **COARP Proved to be a Successful Combat Data Preservation Effort**
 - **Complied with Deputy Secretary of Defense Memo, 31 Jan 91 and AF Office of Assistant Secretary Memo, 5 Feb 91 to Preserve Combat Operations Data**
 - **Combat Data Critical to Improving the Capability of Fielded Systems**
 - **Data Preservation Vital to Design of Next Generation Systems that Are More Survivable and More Effective**
- **SUMMARY OF TECHNICAL RECOMMENDATIONS**
 - **Institute a Program that Includes a Stand-By Capability to Collect Combat Data When Conflicts Occur**

CONSEQUENCES

- **WHAT HAS HAPPENED AS A RESULT OF COMPLETION OF THIS SURVIAC PRODUCT**
 - **Financial Benefits to DoD**
 - Potential to Decrease Aircraft Wartime Attrition Through Application of Lessons Learned
 - **Other Benefits to DoD**
 - Improvement in Combat Effectiveness, Readiness, and Reduction of Casualties
 - **Changes in DoD Operations, Plans, or Procedures as a Direct Result of Product**
 - Wartime Tactics Changed in Response to Combat Operations Lessons Learned

RELEVANCE TO OTHER USERS

- **DATA COLLECTION APPROACH AND METHODOLOGY APPLICABLE TO OTHER APPLICATIONS WHERE A QUICK REACTION CAPABILITY IS REQUIRED**
- **NO DIRECT APPLICABILITY OF THE CURRENT COMBAT DATA OUTSIDE THE DOD**

**ANALYSIS OF EFFECTS OF
NEW WEAPONS SYSTEMS IN THE
EMPLOYMENT OF TACTICAL AIR FORCES**

Prepared by

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Approved for Public Release: Distribution Unlimited

[The final report for this study is Limited Distribution and/or Classified.]

CONTEXT

- PROVIDED C3I SYSTEMS ANALYSIS, MODELING AND SIMULATION CAPABILITY AT ESC/SRPM (MASC) IN SUPPORT OF S&T THRUST 3: AIR SUPERIORITY AND DEFENSE
- DOD FORCE, ROLE, MISSION OR FUNCTION
 - Tactical Air Forces
 - Command Control and Communications
 - Ground Forces

Prepared by: H. W. Wallace-Battelle/
L. W. Williams-TWSTIAC

TWSTIAC-2

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TWSTIAC TASK/BASIC IAC INFORMATION PRODUCT

- **SUBSET OF KEY TECHNOLOGY, S&T THRUST, DOD FORCE, MISSION, ROLE OR FUNCTION OBJECTIVE TO BE ADDRESSED**
 - **Tactical air forces--C3I**
- **TWSTIAC TASK/INFORMATION PRODUCT FOCUS**
 - **Develop, update and validate**
 - **Realistic scenarios**
 - **Databases**

Prepared by: H. W. Wallace-Battelle/
L. W. Williams-TWSTIAC

TWSTIAC-3

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TWSTIAC TASK/BASIC IAC INFORMATION PRODUCT

(Continued)

- **Support investigating the effects and effectiveness of changes to**
 - **Planned weapon systems**
 - **Modifications to existing weapon systems**
- **Rigorous analysis of air combat capability**

Prepared by: H. W. Wallace-Battelle/
L. W. Williams-TWSTIAC

TWSTIAC-4

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TWSTIAC METHODOLOGY

- **METHODOLOGY USED TO PERFORM WORK**
 - **Conducted seminars on**
 - **Doctrine**
 - **Tactics**
 - **Planning (force and unit level)**
 - **Concept of operations/employment**
 - **Develop checklist for MASC staff use**

Prepared by: H. W. Wallace-Battelle/
L. W. Williams-TWSTIAC

TWSTIAC-5

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TWSTIAC APPROACH

- **DEVELOPED SCENARIOS COMPATIBLE WITH MODELS**
 - **EADSIM**
 - **Suppressor**
 - **BRAWLER**
 - **Mitre ADSIM**
- **MEMBER OF CORE TEAM**
 - **Mix of Air Force Mitre and support contractors**
 - **Retains corporate memory**

Prepared by: H. W. Wallace-Battelle/
L. W. Williams-TWSTIAC

TWSTIAC-6

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TWSTIAC APPROACH

(Continued)

- **DATA COLLECTION**
 - **Battelle-held data**
 - **SPOES**
 - **Operational units and headquarters**
- **WORK IN SECURE AIR FORCE FACILITY (HANSKOM AFB)**
- **INFORMATION HOLDINGS AND STAFF EXPERTISE**
- **DATA ON WEAPON SYSTEMS**
- **Scenarios**

Prepared by: H. W. Wallace-Battelle/
L. W. Williams-TWSTIAC

TWSTIAC-7

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SUMMARY OF DATA

- **DATA COLLECTED**
 - **Blue weapons systems**
 - **Red weapons systems**
 - **Doctrine/tactics for both**
 - **Adapt to different models for realistic simulation**

Prepared by: H. W. Wallace-Battelle/
L. W. Williams-TWSTIAC

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RESULTS OF DATA ANALYSIS

- **FINDINGS RESULTING FROM ANALYSIS OF DATA COLLECTED BY TWSTIAC**

- **Realistic scenarios and data used to analyze**
 - **AWACS improvements**
 - **Joint Stars self defense**
 - **JINTACS usefulness**
 - **TMD operations**

- **SUMMARY OF TECHNICAL RECOMMENDATIONS**

- **Add equipment to AWACS**
- **Add equipment to Joint Stars**
- **JINTACS will improve combat effectiveness of fighters**

Prepared by: H. W. Wallace-Battelle/
L. W. Williams-TWSTIAC

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CONSEQUENCES

- **WHAT HAS HAPPENED AS A RESULT OF COMPLETION OF THIS IAC PRODUCT?**
 - **Supported decisions to improve the AWACS**
 - **Higher kill rates by Blue fighters**
 - **Supported decisions to improve the Joint Stars**
 - **Better information to land commanders**
 - **Lower Blue casualties**
- **METHODOLOGY HAS BEEN PERPETUATED BY THE AIR FORCE TO SUPPORT COMMAND AND CONTROL DEVELOPMENTS**

Prepared by: H. W. Wallace-Battelle/
L. W. Williams-TWSTIAC

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RELEVANCE TO OTHER USERS

- **OTHER SERVICES COULD EMPLOY THE METHODOLOGY TO GUIDE MODELING, SIMULATION, DEVELOPMENTS FOR COMMAND AND CONTROL**

Prepared by: H. W. Wallace-Battelle/
L. W. Williams-TWSTIAC

TWSTIAC-11

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ASSESSMENT OF ULTRA-WIDEBAND (UWB) RADAR TECHNOLOGY

Prepared by

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Approved for Public Release: Distribution Unlimited

[The final report for this study is Limited Distribution and/or Classified. AD B146 160]

CONTEXT

- **DoD S&T THRUSTS 1: GLOBAL SURVEILLANCE AND COMMUNICATIONS, 2: PRECISION STRIKE, AND 3: AIR SUPERIORITY AND DEFENSE**
- **DoD KEY TECHNOLOGIES: SENSORS/RADAR SENSOR TECHNOLOGY**
- **DoD MILITARY MISSIONS/FUNCTIONS: STRATEGIC FORCES, AIR DEFENSE**

Prepared by: V. G. Pugliesi-Battelle/
L. W. Williams-TWSTIAC

TWSTIAC-2

Pugliesi.vu

TWSTIAC TASK/BASIC INFORMATION PRODUCT

TWSTIAC WAS ASKED TO:

- **EXAMINE THE STATE OF THE ART AND POTENTIAL BENEFITS OF UWB TECHNOLOGY, PARTICULARLY FOR RADAR APPLICATIONS**
- **IDENTIFY AND PRIORITIZE RESEARCH TO BE PURSUED**

**Prepared by: V. G. Puglielli-Battelle/
L. W. Williams-TWSTIAC**

TWSTIAC-3

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TWSTIAC METHODOLOGY

- **BLUE RIBBON PANEL OF RESIDENT AND NATIONAL EXPERTS ON UWB TECHNOLOGY AND RADAR**
- **REVIEWED PRIOR UWB RADAR DEVELOPMENT**
 - **Experimental data**
 - **Literature--including Soviet**
- **REVIEWED ONGOING AND PROPOSED WORK**
 - **Government laboratories**
 - **Industry and academia**
- **DETERMINED POTENTIAL PERFORMANCE BENEFITS**
 - **Radar technologies, including against low-observable targets**
 - **Countermeasures, especially probability of detection**

Prepared by: V. G. Puglielli-Battelle/
L. W. Williams-TWSTIAC

TWSTIAC-4

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TWSTIAC METHODOLOGY (Continued)

- **IDENTIFIED TECHNOLOGY ISSUES/GAPS IN KNOWLEDGE/
PRIORITY OF IMPORTANCE**
- **RECOMMENDED NEEDED RESEARCH**
 - **Areas for further investigation**
 - **Experimental tools/hardware needed**
- **DETERMINED POSSIBLE APPLICATIONS**

Prepared by: V. G. Puglielli-Battelle/
L. W. Williams-TWSTIAC

TWSTIAC-5

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ASSISTANCE DELIVERED

- **CONCENTRATED ON CHARACTERISTICS OF AND CLAIMS MADE FOR UWB TECHNOLOGY: RADAR, COMMUNICATIONS, ELECTRONIC WARFARE AND RF WEAPONIZATION**
 - No applications were advanced for communications
 - Government in-house committee was addressing applications to EW and RF weaponization
 - Therefore, this study concentrated on radar applications
- **FOCUSED ON CLAIMS FOR ULTRA-WIDEBAND "IMPULSE" RADAR AS BEING INHERENTLY:**
 - Counter-stealth (i.e., to defeat the F-117 and the B-2)
 - Low Probability of Intercept (LPI) (to defeat countermeasures)
 - Capable of detecting relocatable targets in camouflage/foilage
- **REVIEWED THE THEORETICAL BASES FOR CLAIMED CAPABILITIES**

Prepared by: V. G. Puglielli-Battelle/
L. W. Williams-TWSTIAC

TWSTIAC-6

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RESULTS OF DATA ANALYSIS

- **IMPULSE RADAR IS NOT INHERENTLY COUNTER-STEALTH**
 - **Conventional radars are able to exploit any vulnerabilities resulting from target shaping**
 - **No effects in RAM are unique to impulse radar**
- **IMPULSE RADAR IS NOT INHERENTLY DIFFICULT TO DETECT**
 - **It is difficult to make any radar hard to detect**
 - **Impulse radar has no special LPI characteristics, is readily detected by an appropriately designed intercept receiver**
- **A PROPERLY DESIGNED IMPULSE RADAR MIGHT BE ABLE TO DETECT TARGETS SHIELDED BEHIND TREES (AS MIGHT ANY NON-IMPULSE UWB RADAR)**

Prepared by: **V. G. Puglielli-Battelle/
L. W. Williams-TWSTIAC**

TWSTIAC-7

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RESULTS (Continued)

- **ADVANCES IN SOURCES FOR VERY HIGH POWER SHORT PULSES MIGHT BENEFIT CONVENTIONAL SHORT PULSE RADAR AS WELL AS IMPULSE TRANSMITTERS**
- **CONVENTIONAL RADAR THEORY IS COMPLETELY ADEQUATE FOR UNDERSTANDING IMPULSE RADAR PHENOMENA--THERE IS NO UNIQUE THEORETICAL BASIS FOR UWB RADAR**
- **RECOMMENDATIONS WERE MADE:**
 - **Do analyses of point designs using both impulse and non-impulse radar approaches for four military applications**
 - **Do studies of clutter behavior of UWB radar systems and characteristics of UWB antennas**
 - **Do a modest study to document characteristics of self-induced transparency and other non-linear effects possibly relevant to military systems**

Prepared by: V. G. Puglielli-Battelle/
L. W. Williams-TWSTIAC

TWSTIAC-8

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CONCLUSIONS

- **INTERESTING WORK WAS UNDER WAY, AND SELECTED/LIMITED R&D INVESTMENTS COULD EXPLORE ITS POTENTIAL BENEFITS**
- **IMPULSE RADAR DOES NOT OFFER A MAJOR NEW MILITARY CAPABILITY, NOR DOES IT THREATEN A SERIOUS TECHNOLOGICAL SURPRISE**

Prepared by: V. G. Puglielli-Battelle/
L. W. Williams-TWSTIAC

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CONSEQUENCES

- **WHAT HAS HAPPENED AS A RESULT OF THIS EFFORT?**

- **Financial benefits to DoD**

- Congress had mandated \$25M FY90 funds be spent on this technology. This effort helped to focus investment of \$10M FY90-91 and \$12M FY92-93 funding for UWB into theoretically sound, technologically promising, and operationally appropriate R&D
- Avoided "Loss Leader" construction of an unnecessary UWB radar site-- future investments could have been multiples of \$25M

- **Other benefits to DoD**

- Disproved unfounded challenges against the viability of stealth technologies
- Discredited claims that the U.S. was at risk of major technological surprise
- Brought some discipline and technical foundation to a highly visible, poorly described technology as an aid to decision makers
- Laid the foundation for subsequent technology developments which are significant for several applications, the most notable proving to be foliage penetration radar.

Prepared by: V. G. Pugliese-Battelle/
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TWSTIAC-10

Pugliese, VU

RELEVANCE TO OTHER USERS

- **THE METHODOLOGY OF A "BLUE RIBBON" TEAM OF HIGH QUALITY/INTEGRITY UNDER IMPARTIAL ORGANIZATIONAL LEADERSHIP CAN BE APPLIED TO ANY PROBLEM WHERE TECHNICAL CONFUSION IS WIDESPREAD AND UNUSUAL CLAIMS MAY BE THE BASIS FOR DoD INVESTMENT**
- **THE REPORT STANDS AS A SOUND GUIDE FOR FUTURE PLANNERS IN THIS TECHNOLOGY. THE BASIC PHYSICS WHICH FORMS THE REPORT'S FOUNDATION WILL NOT CHANGE WITH TIME. THE TECHNOLOGY CONTINUES TO ADVANCE ALONG THE LINES PREDICTED.**

Prepared by: V. G. Puglielli-Battelle/
L. W. Williams-TWSTIAC

TWSTIAC-11

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SEA CONTROL AND UNDERSEA SUPERIORITY

**EVALUATION OF FEASIBILITY
OF A
BIOLOGICAL AGENT DETECTION CONCEPT**

Prepared by

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Approved for Public Release: Distribution Unlimited

CONTEXT

- **SEA CONTROL**
 - **Naval Interdictions**
 - **Operate in Littoral Zones**
 - **Sustain Operations and Enhance Survivability**
- **CBR ENVIRONMENT LIKELY (OFFICE OF NAVAL INTELLIGENCE)**
 - **Proliferation of Agents and Delivery Capabilities**
 - **Large Area Coverage Weapons**
 - **Former Soviet Union, Third World and Terrorists**
 - **Increased Risk to Naval Personnel**

IAC TASK

- **WHAT**
 - **Evaluate the Feasibility of a Proprietary Biorefractometer for use as a Biological Agent Detector**
- **WHY**
 - **Need to Satisfy a Naval Requirement for Biological Agent Detection**
 - **Prioritized as a Result of Operation Desert Storm (ODS)**
- **WHO**
 - **U.S. Naval Surface Warfare Center (Dahlgren Division)**

IAC METHODOLOGY

- **PERFORM LABORATORY EVALUATION TO ESTABLISH PROOF OF CONCEPT FOR A DEVICE**
 - **Measure Sensitivity and Response Time of a Sensor to a Protein of Military Significance (Ricin Toxin)**
 - **Evaluate Proximity Effects on Sensitivity and Response**
 - **Examine Non-Specific Reagent and Small Particle Effects to Sensor Surface**

RESULTS

- **PROOF OF CONCEPT ESTABLISHED**
 - **Detection Goals Exceeded**
 - **Other Attributes Promising**

CONSEQUENCES

- **IDENTIFIED POTENTIAL SOLUTION FOR DETECTION OF BIOLOGICAL WARFARE AGENTS**
 - **Small**
 - **Rugged**
 - **Simple to Operate**
 - **Low Relative Cost**
- **STIMULATED INTEREST OF OTHER SERVICES IN THE TECHNOLOGY**

RELEVANCE TO OTHER USERS

- **MEDICAL COMMUNITY**
 - **Military Medical for Infectious Diseases**
 - **Commercial Medical for Rapid Auto Diagnostic**
- **ENVIRONMENTAL COMMUNITY**
 - **Airborne and Water Sensing of Pollutants**
- **OTHER CBR INTERESTS**
 - **As Novel Chemical Warfare Agent Sensor**
 - **For Confirmatory Use Associated with CW Treaty Verification**

**INTERACTIVE DECISION TRAINING SCENARIO FOR USN
DAMAGE CONTROL AND CBR-D DECISION TRAINING**

Prepared by

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CONTEXT

- **SEA CONTROL AND TACTICAL NAVAL SURFACE FORCES**
 - **Naval Interdictions**
 - **Operate in Littoral Zones**
 - **Losses to a Minimum**
- **NBC ENVIRONMENT LIKELY**
 - **Proliferation**
 - **Increased use Scenarios**

IAC TASK

- **WHAT**
 - **Interactive Damage Control Scenario Presentation System (DECAID)**
- **WHY**
 - **Risk Management Essential in CBR Environments**
 - **Increased Burdens**
 - **Competing Demands**
 - **Training Shortfall -- Integration of CBR Defense with other Damage Control Functions**
- **WHO**
 - **U.S. Naval Training Systems Center**

IAC METHODOLOGY

- **DEVELOP DAMAGE CONTROL DECISION TASKS AND RISK MANAGEMENT DILEMMAS**
- **DEVELOP DECAID SCENARIOS**
 - **Fire**
 - **Flood**
 - **Chemical Attack**
 - **Combinations**
- **DEVELOP DECAID RULE BASE USING INPUT FROM SUBJECT MATTER EXPERTS (SMES)**
- **DEVELOP INTERACTIVE DEMONSTRATION**
- **REVIEW BY NAVY USERS**

SUMMARY OF DATA

- **DEVELOPED**
 - **Scenarios**
 - **Interface Features**
 - **Controls, Displays, etc**
 - **Rules**
 - **Firemen, crew, event**
 - **Software (Primarily in C)**
- **CONDUCTED DEMONSTRATIONS**

RESULTS

- **SUCCESSFUL "6.2" DEMONSTRATION OF CONCEPT**
 - **Instructors of Navy Advance CBR Course**
 - **Surface Warfare Officer School**

CONSEQUENCE

- **PRODUCT INTEGRATED INTO NAVY TRAINING COURSE**
- **USN PURSUING ADDITIONAL DEVELOPMENT**

SHIP SUPERSTRUCTURE ICING

Presented by

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CECRL-ORTA**

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CONTEXT

- **DOD KEY TECHNOLOGY**
 - Environmental Effects: The automated generation of near-real-time environmental tactical decision aids to determine the adverse effects of dynamic battlefield environments on characterization and modeling of military requirement and operations.
- **DOD SCIENCE AND TECHNOLOGY THRUST**
 - Sea control and undersea superiority. The need to maintain an overseas presence and operate in littoral zones in a broad range of environmental conditions.
- **DOD CRITICAL TECHNOLOGY**
 - Simulation and Modeling

IAC TASK / BASIC INFORMATION PRODUCT

- **RESEARCH OBJECTIVE:**

- Allow vessels to avoid hazardous conditions or to minimize the accretion of ice by predicting:
 - » Environmental conditions under which icing may occur
 - » Icing rates
 - » Predominant icing locations on the vessel

- **IAC PRODUCT FOCUS**

- Survey and analyze existing ship spray icing models
- Evaluate available data on ship icing
- Customer: U.S. Navy David W. Taylor Naval Ship Research Center

SUMMARY OF DATA

- **MODELS**
 - Most are empirical and based on trawler data
 - Do not consider the physical processes they simulate
 - Cannot be transferred to larger ships
 - University of Alberta numerical ship icing model
- **DATA**
 - Lack of data on large ship icing

Prepared by: P. D. Smallidge

IAC-ICE-3

CONSEQUENCES

- **RESEARCH EFFORTS**
 - Calibration and validation of Alberta model
 - Development and evaluation of spray and ice measurement equipment
 - Research cruise USCGC Midget
- **RESULTS**
 - Good video and weather data
 - Partial success on automated spray and icing measurements
 - Sufficient data to verify Alberta model for Navy

RELEVANCE TO OTHER USERS

- **OTHER DIRECT APPLICATIONS**
 - Shoreline / coastal facilities
 - » Logistics over the shore
 - » Coastal radar / communications facilities
 - » Offshore oil platforms
 - Commercial fishing and shipping
- **SPINOFFS**
 - Shipboard instrumentation lessons learned

MISSION ANALYSIS OF FUTURE ENHANCED SURVIVABILITY SHIP PLATFORMS

Prepared by

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Approved for Public Release: Distribution Unlimited

[The final report for this study is Limited Distribution and/or Classified.]

CONTEXT

- S&T THRUST 4: SEA CONTROL
- DoD MILITARY MISSIONS/ROLES/FUNCTIONS: SEA CONTROL AND ASW

Prepared by: R. Widder-Battelle/
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L. W. Williams-TWSTIAC

TWSTIAC-2

Widder.vu

Future Navy Operations

"When that war (i.e., Desert Storm) is over, we must continue to forge a national policy that is consistent with and fosters the new world order. It will be especially important for the Department of the Navy to be realistic about expected sources and force structure. Nevertheless, we will continue our vital contribution in stability and security on the seas and throughout the littoral regions of the world."

**The Secretary of the Navy's
Posture Statement, Feb, 1991**

In other words, the U.S. Navy will have to:

- Operate in wider range of situations and locations,**
 - with existing platform classes**
 - with fewer platforms,**
 - against threats employing a wider variety of doctrines**
 - against threats with greater technological diversity**

PURPOSE

- **ANALYZE THE MILITARY WORTH OF READILY AVAILABLE RADAR CROSS SECTION (RCS) REDUCTIONS ON EXISTING COMBATANT VESSELS**
 - **Phase I - Against Soviet threat**
 - **Phase II - Against Third World threats, U.S. force operating without air cover**

Prepared by: R. Widder-Battelle/
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TWSTIAC-3

Widder.vu

Potential Areas of Crises



Ref: "1991 Joint Military Net Assessment", Mar 1991 JCS, (U)

Scenarios for Mission Analysis

A set of scenarios is selected for study - derived from 1991 Joint Military Net Assessment by JCS/J-5, and which includes:

- **Major regional contingency (e.g., Korea or SWA). Mid to High Intensity; 120 days of combat**
- **Lesser regional contingency - Low to Mid intensity: 90 days of combat**
- **Counter-Insurgency/counter-narcotics (Central America, South America and/or Republic of Philippines)**
- **War escalating from a European crisis. Mid to High intensity; more than 50 days of combat.**

NOTE: Scenarios are valuable for testing the credibility of realistic environments, natural or assumed.

Regional Conflict, Southern Med (Libya)

- **U.S. organizes SAG Naval cruise missile strike force as part of UN security council resolution to conduct operations against hardened libyan air land targets to neutralize capability to bases on Libyas southern border with Chad.**
- **No U.S. carriers in Med. They have been committed to hostilities in Korea.**
- **U.S. action would begin by SAG approaching hostile country coastline within approximately 100 NMI to launch cruise missiles at military installations; airfields, factories, A/C parking lots, revetments, ammo depots, etc.**
- **SAG will defend against sea and land-based missile batteries and aircraft launched weapons with AEGIS missile weapon system.**

Libyan Strike I

U.S. Objective -

Conduct TLAM-C strike on air bases in southern Libya, to be followed by UK-French/UN Coalition air strikes.

U.S. Forces -

SAG, consisting of:

(3) DDG-51

(1) CG-52

(1) DD-963 (VLS)

AEW:

(1) E-3A (AWACS)

Libyan Forces -

Bombers/Fighter Bombers:

(4) TU-22 Blinder (used for reconnaissance w/RF Link to)

(24) Mirage F-1, 5D

Submarines:

(4) Foxtrot (Diesel-Electric) Submarines

(14) Libyan surface missile craft

TWSTIAC APPROACH

PHASE I

- **UTILIZE STANDARD SCENARIOS**
 - **CVBG attacked by ALCMs & SLCMs**
 - **Leakers engaged by AEGIS and Ship Self-Defense System**
- **ANALYZE EFFECT OF ACHIEVABLE RCS REDUCTION ON CVBG SURVIVABILITY**

PHASE II

- **DEVELOP SCENARIOS FOR POST-COLD WAR ENGAGEMENTS**
 - **SAG attacked by ALCMS and missile boats**
 - **Missiles engaged by AEGIS & Ship Self-Defense System**
- **ANALYZE EFFECT OF ACHIEVABLE RCS REDUCTION ON SAG SURVIVABILITY**

Prepared by: R. Widder-Battelle/
J. N. Lesko-Battelle/
L. W. Williams-TWSTIAC

TWSTIAC-4

Widder.vu

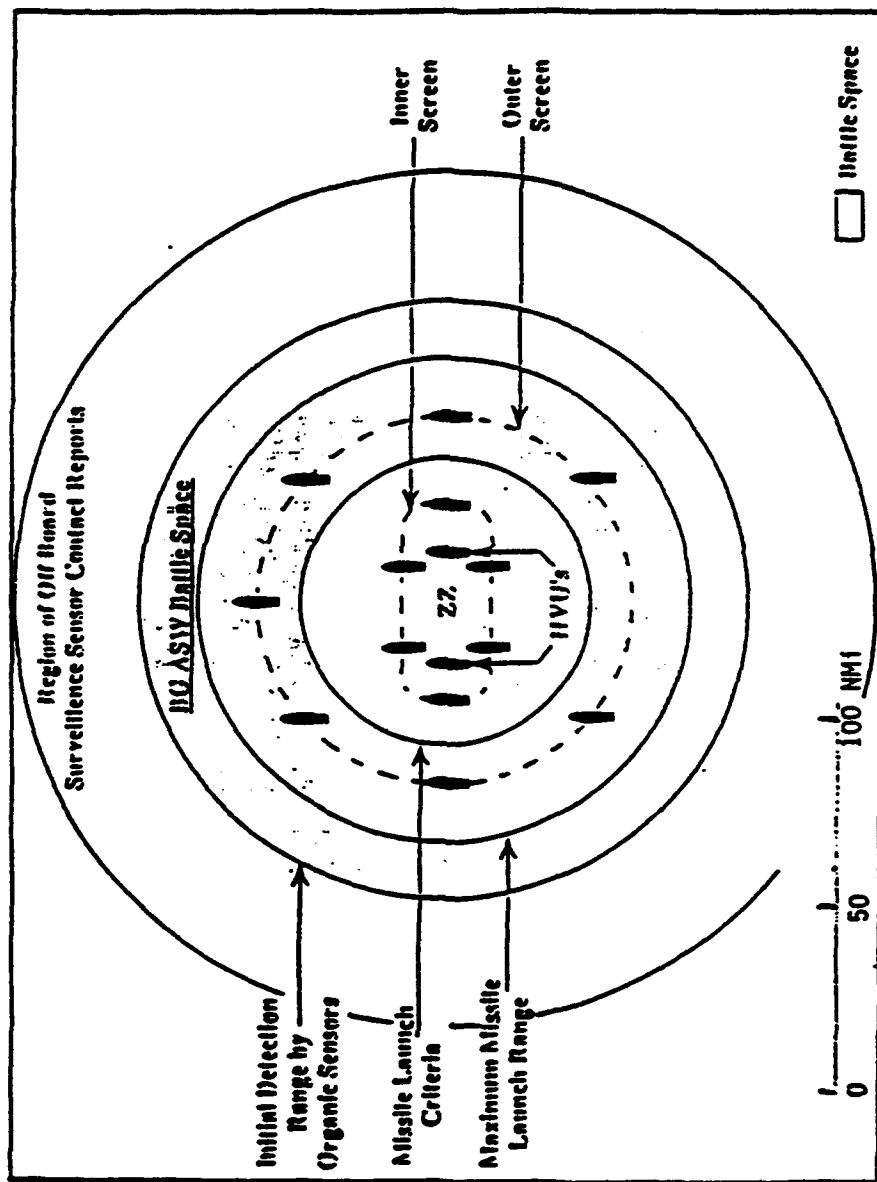
TWSTIAC METHODOLOGY

- REVIEW EXISTING SCENARIOS (FOR PHASE I)
- DEVELOP NEW SCENARIOS BASED ON J-5 INPUTS (FOR PHASE II)
- OBTAIN SYSTEM PERFORMANCE PARAMETERS FROM DATABASE
- DEVELOP VALUES FOR ACHIEVABLE RCS REDUCTION
- CALCULATE P
S FOR EXISTING AND REDUCED RCS PLATFORMS,
BASED ON
 - Defensive hard kill
 - Defensive softkill
 - Synergistic effects
- PROVIDE RECOMMENDATIONS
 - Classified recommendations made to DARPA

Prepared by: R. Widder-Battelle/
J. N. Lesko-Battelle/
L. W. Williams-TWSTIAC

TWSTIAC-5

Widder.vu



(UNCLASSIFIED)

RESULTS

- **READILY ACHIEVABLE RCS REDUCTIONS FOUND BENEFICIAL IN ENHANCING SHIP SURVIVABILITY IN BOTH SCENARIOS**
- **SHIP SURVIVABILITY IS FURTHER ENHANCED BY INTEGRATION OF ACTIVE AND PASSIVE DEFENSIVE MEASURES**

Prepared by: R. Widder-Battelle/
J. N. Lesko-Battelle/
L. W. Williams-TWSTIAC

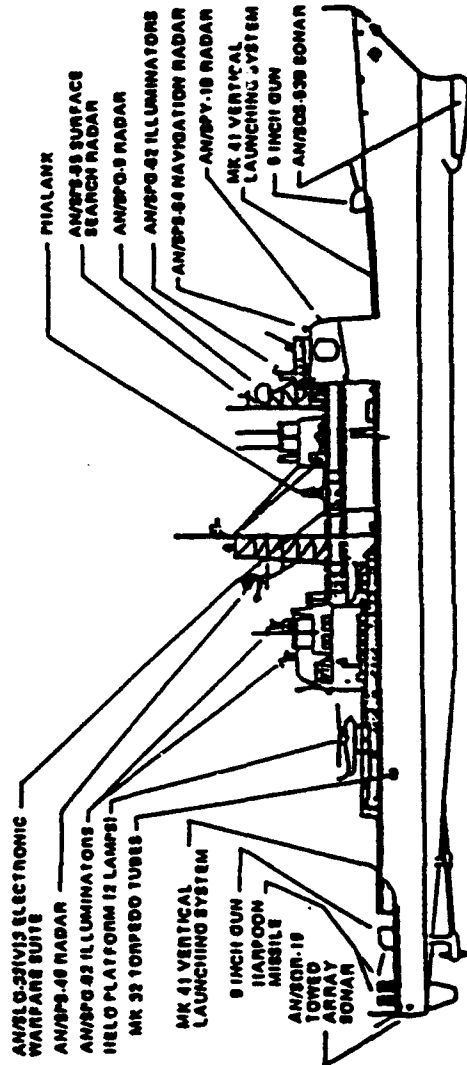
TWSTIAC-6

Widder.vu

Ship Characteristics (CG 64)

LENGTH..... 567 FEET
 BEAM..... 85 FEET
 SPEED..... 30 + KNOTS
 DRAFT (KEEL)..... 23.2 FEET

DRAFT (NAVIGATION)..... 32 FEET
 DISPLACEMENT..... 9,916 TONS
 ACCOMMODATIONS..... 37 OFFICERS
 48 CHIEF PETTY OFFICERS
 327 ENLISTED



PROPULSION

4 LM2500 GAS TURBINE ENGINES, 80,000 SHAFT HORSEPOWER
 2 CONTROLLABLE REVERSIBLE PITCH PROPELLERS
 2 RUDDERS

SENSORS

1 AN/SPY-1B RADAR (FOUR ARRAYS)
 1 AN/SPS-48 AIR SEARCH RADAR
 1 AN/SPS-95 SURFACE SEARCH RADAR
 1 AN/SPS-64 NAVIGATION RADAR
 1 AN/SPG-9 SURFACE SURVEILLANCE AND TRACKING RADAR
 4 AN/SPG-62 ILLUMINATORS
 1 AN/SOR-19 TOWED-ARRAY SONAR
 1 AN/SOS-53B SONAR
 1 AN/SLQ-32(V)3 ELECTRONIC WARFARE SUITE

WEAPONS

1 MK 7 MOD 4 AEGIS WEAPONS SYSTEM
 2 MK 45 6"/74 CALIBER LIGHTWEIGHT GUN MOUNTS
 2 MK 41 VERTICAL LAUNCHING SYSTEMS (VLS)
 2 HARPOON MISSILE QUAD-CANNISTER LAUNCHERS
 2 MK 32 MOD 14 TORPEDO TUBES
 1 MK 16 MOD 12 CLOSE-IN WEAPONS SYSTEM (2 MOUNTS)
 1 MK 38 MOD 6 SUPER RAPID-BLOOMING OFF BOARD CHAFF SYSTEM
 4 50 CALIBER MACHINE GUNS

COMMAND AND CONTROL

MK 1 MOD 0 AEGIS DISPLAY GROUP

AIRCRAFT

2 LAMPS MK III (S11-80B)

CONSEQUENCES

- **STUDY BRIEFED TO OPNAV**
- **OPNAV REQUESTED ADDITIONAL ANALYSES FROM DARPA TO SUPPLEMENT THEIR SHIP SELF-DEFENSE STUDY**
- **ADDITIONAL EFFORT NOT UNDERTAKEN DUE TO SHIFT OF INTEREST IN DARPA**

Prepared by: R. Widder-Battelle/
J. N. Lesko-Battelle/
L. W. Williams-TWSTIAC

TWSTIAC-7

Widder.vu

ADVANCED LAND COMBAT

**BIO TECHNOLOGY: A SURVEY OF SEVEN
TECHNOLOGIES TO IDENTIFY CLOSTRIDIUM
BOTULINUM AND BACILLUS ANTHRACIS**

Prepared by

**Dr. Salvatore Bosco, Dr. Leo Laughlin, Milton Miles and James McNeely
CBIAC
Chemical Biological Information Analysis Center
Battelle
2113 Emmorton Park Road
Edgewood, MD 21040**

Approved for Public Release: Distribution Unlimited

CONTEXT

- **BIOLOGICAL WARFARE CONVENTION TECHNICAL DISCUSSIONS**
- **IDENTIFY TECHNICAL ISSUES ASSOCIATED WITH DEVELOPMENT OF VERIFICATION INITIATIVES**

Prepared by: Salvatore Bosco, et al

CBIAC - 2



BIO TECHNOLOGY TASK

- **WHY**
 - **Technical Exchanges**
 - **International Assertions on BWC Verifiability**
 - **Claims of Equipment Capabilities**
 - **Provide Common Denominator for Comparison of Technical Specifications**
 - **Need to Define Technical Terminology**
 - **Capture Current Information on Rapid-Paced Technological Advances**
 - **Provide Technical Information to Negotiators who have Little Technical Background**
 - **Technical and Policy Experts use same "Sheet of Music"**
 - **Need to Address Real-World Problems**
 - **False Positive (vs False Negatives)**
 - **Masking Issues/Interferences**
- **WHO**
 - **Office of the Secretary of Defense (OSD/ISP/MN)**
- **WHAT**
 - **Technical Review of Leading Edge Technologies for Identification of Botulinum and Anthrax**

IAC METHODOLOGY

- **SCOPE TO WORKABLE SET OF TECHNOLOGIES FOR PROOF OF CONCEPT**
- **WORLD-WIDE SEARCH FOR RELEVANT LITERATURE**
- **CULL FOR QUANTITATIVE INFORMATION ON SPECIES IDENTIFICATION**
- **MATRIX TECHNOLOGIES VS AGENTS**
- **CREATE ROLL-UP SECTIONS WITH INCREASING DEGREES OF TECHNICAL DETAIL**
- **THOROUGHLY REFERENCED**
- **EXPERT REVIEW AND EVALUATION OF TECHNICAL/MEDICAL LITERATURE**

SUMMARY OF DATA

- **OVERVIEW OF CUTTING-EDGE TECHNOLOGIES**
- **REVIEW OF APPLICABILITY TO SPECIFIC IDENTIFICATION**
- **EXPERIENCED SCIENTISTS FOR EVALUATION**
- **MATRIX PRESENTATION ALLOWS FOR EASY EXTENSION TO OTHER DISEASE-CAUSING ORGANISMS OF INTEREST**

RESULTS OF DATA ANALYSIS

- **BW TECHNOLOGY DOCUMENT PROVIDED U.S. NEGOTIATORS WITH DATA TO EFFECTIVELY RESPOND TO PROPOSALS FOR BWC VERIFICATION REGIMES**

CONSEQUENCES

- **DOCUMENT PROVIDED TO U.S. BWC TECHNICAL REPRESENTATIVES**
- **EXTRACTS OF DOCUMENT DISTRIBUTED TO INTERNATIONAL DELEGATES**

RELEVANCE TO OTHER USERS

- **WORLD HEALTH ORGANIZATION**
- **INDUSTRY**
- **NATIONAL INSTITUTE OF HEALTH**
- **CENTER FOR DISEASE CONTROL**
- **ACADEMIA**

**EVALUATION OF LIGHTWEIGHT INTEGRATED SUIT
TECHNOLOGIES (LIST) AND ASSOCIATED TEST
METHODS**

Prepared by

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Approved for Public Release: Distribution Unlimited

CONTEXT

- **ADVANCED LAND COMBAT (S&T THRUST)**
 - **Rapid Force Deployment**
 - **Tactical Mobility**
 - **Quick Mission Accomplishment**
 - **Minimal Casualties Against Heavy Armor and Smart Weaponry**
- **NBC ENVIRONMENT LIKELY**
 - **Proliferation**
 - **Biotechnology Advances**
 - **Affects Battlefield Dynamics**
 - **Survivability**
 - **Performance Degradation**
 - **Support**

IAC TASK

- **WHAT**
 - **Resolve Issues Resulting from the use of two Different Test Methods to Evaluate Protective Clothing**
 - **Validate without Polyethylene Film Test**
 - **Correlate with and without Film Methods**
 - **Fill Critical Gaps in Database for Current and Developing Material Technologies**
 - **Determine the Effects of Wearing Suits Upon Levels of Protection Provided**
- **WHY**
 - **Improved Protective Capabilities Needed**
 - **Reduction in Heat Stress**
 - **Reduction in Logistical Support Requirements**
 - **More Sensitive Test Method Needed**
- **WHO**
 - **U.S. Army**

IAC METHODOLOGY

- **PERFORM SIDE BY SIDE COMPARISONS OF TEST METHODS**
 - **Test Worn Suit Materials using both Methods**
- **ATTEMPT TO CORRELATE TEST RESULTS**

RESULTS

- **WORN LIGHTWEIGHT SUIT MATERIALS SHOWN TO PROVIDE ADEQUATE LEVELS OF CHEMICAL AGENT RESISTANCE**
- **DATA GENERATED USING DIFFERENT METHODS COULD NOT BE CORRELATED**
- **"RELATIVE" RANKINGS OF SUIT MATERIALS FOUND TO BE SIGNIFICANTLY DIFFERENT DEPENDING UPON METHOD USED**
- **TESTING WITHOUT FILM FOUND TO BE MORE SENSITIVE AND A BETTER METHOD FOR QUANTIFYING THE EFFECTS OF WEAR**

CONSEQUENCES

- **PROVIDED VALUABLE GUIDANCE FOR WEAR AND LOGISTICAL SUPPORT OF LIGHTWEIGHT CLOTHING DURING OPERATION DESERT STORM (ODS)**
- **WITHOUT PE FILM ADOPTED AS THE U.S. STANDARD SWATCH TEST METHOD FOR MATERIALS EVALUATION**
- **STANDARDIZED QUALITY CONTROL AND QUALITY ASSURANCE METHODS FOR EVALUATION OF CHEMICAL PROTECTIVE CLOTHING MATERIALS**
- **EVOLUTION OF JOINT SERVICES PROGRAM - JSLIST**

RELEVANCE TO OTHER USERS

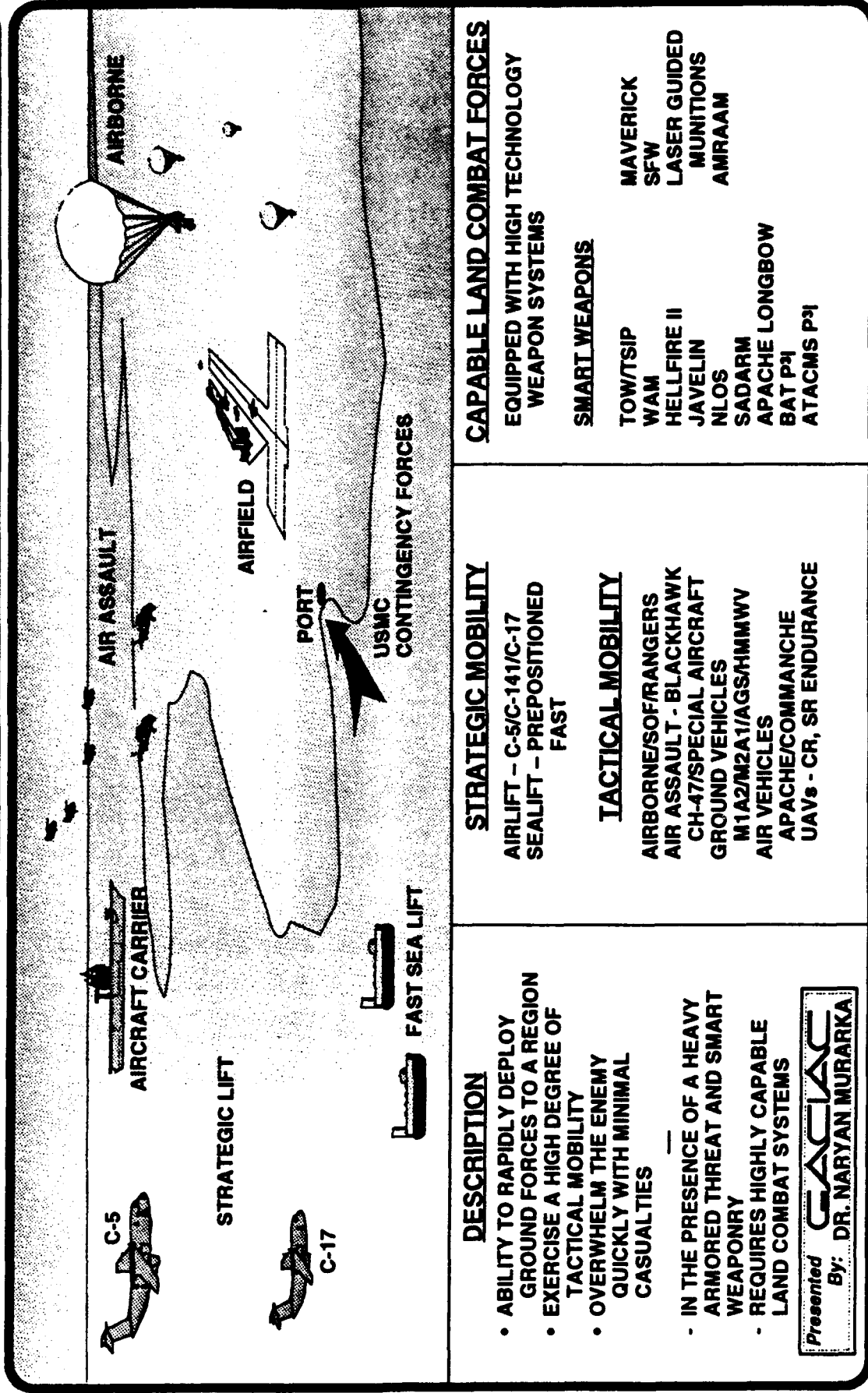
- **ORGANIZATIONS RESPONSIBLE FOR ESTABLISHING STANDARDS AND TEST METHODS FOR CHEMICAL PROTECTIVE CLOTHING (CPC)**
 - **ASTM**
 - **ISO**
- **TESTERS OF CPC**
- **USERS OF CPC**
 - **Hazmat Teams**
 - **Department of Transportation (DOT)**
 - **Department of Energy (DOE)**
 - **Manufacturers of Hazardous Chemicals**



ADVANCED LAND COMBAT

**PREPARED BY
DR. NARYAN MURARKA
GUIDANCE AND CONTROL INFORMATION ANALYSIS CENTER
IIT RESEARCH INSTITUTE
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CHICAGO, IL 60616**

ADVANCED LAND COMBAT CONTEXT



DESCRIPTION

- ABILITY TO RAPIDLY DEPLOY GROUND FORCES TO A REGION
- EXERCISE A HIGH DEGREE OF TACTICAL MOBILITY
- OVERWHELM THE ENEMY QUICKLY WITH MINIMAL CASUALTIES
- IN THE PRESENCE OF A HEAVY ARMORED THREAT AND SMART WEAPONRY
- REQUIRES HIGHLY CAPABLE LAND COMBAT SYSTEMS

Presented By: DR. NARYAN MURARKA

STRATEGIC MOBILITY

AIRLIFT - C-5/C-141/C-17
SEALIFT - PREPOSITIONED FAST

TACTICAL MOBILITY

AIRBORNE/SOF/RANGERS
AIR ASSAULT - BLACKHAWK
CH-47/SPECIAL AIRCRAFT
GROUND VEHICLES
M1A2/M2A1/AGS/MMMWV
AIR VEHICLES
APACHE/COMMANCHE
UAVs - CR, SR ENDURANCE

CAPABLE LAND COMBAT FORCES

EQUIPPED WITH HIGH TECHNOLOGY WEAPON SYSTEMS

SMART WEAPONS

TOW/TSP
WAM
HELLFIRE II
JAVELIN
NLOS
SADARM
APACHE LONGBOW
BAT P31
ATACMS P31

MAVERICK
SFW
LASER GUIDED MUNITIONS
AMRAAM

ADVANCED LAND COMBAT MODELING / SIMULATION IAC TASKS

GACIAC SPECIAL TASKS

- **GENESIS**
 - SMART WEAPONS MANY-ON-MANY MODEL
 - FOCUSES ON SUBMUNITION ENDGAME ANALYSIS
 - VISUALLY DEPICTS SUBMUNITION FLYOUT/FOOTPRINT SEARCH
 - USEFUL IN EVALUATING NEW CONCEPTS/SYSTEM P³I
- **SADARM ONE-ON-ONE SIMULATION DEVELOPED TO SUPPORT PM**
- **BAT P³I ANALYSIS IS USING GENESIS TO EVALUATE GENERIC SEEKER CAPABILITY AND VARIOUS P³I ALTERNATIVES**
- **HARDWARE-IN-THE-LOOP SIMULATION USED TO EVALUATE STINGER AIR DEFENSE SEEKER CAPABILITY**
- **PM SURVIVABILITY SYSTEMS HAS USED GENESIS TO EVALUATE THE IMPACT OF ELECTRONIC COUNTERMEASURES ON BLUE GROUND VEHICLE SYSTEMS**
- **GENESIS MODEL USED TO ASSESS THE IMPACT OF COUNTERMEASURES ON SMART WEAPON SYSTEMS - SADARM/MLRS-TGW**

**MODELING/SIMULATION SUPPORTS THE DEVELOPMENT OF KEY SYSTEMS
FOR ENHANCING LAND FORCE CAPABILITY**



ADVANCED LAND COMBAT SMART WEAPONS

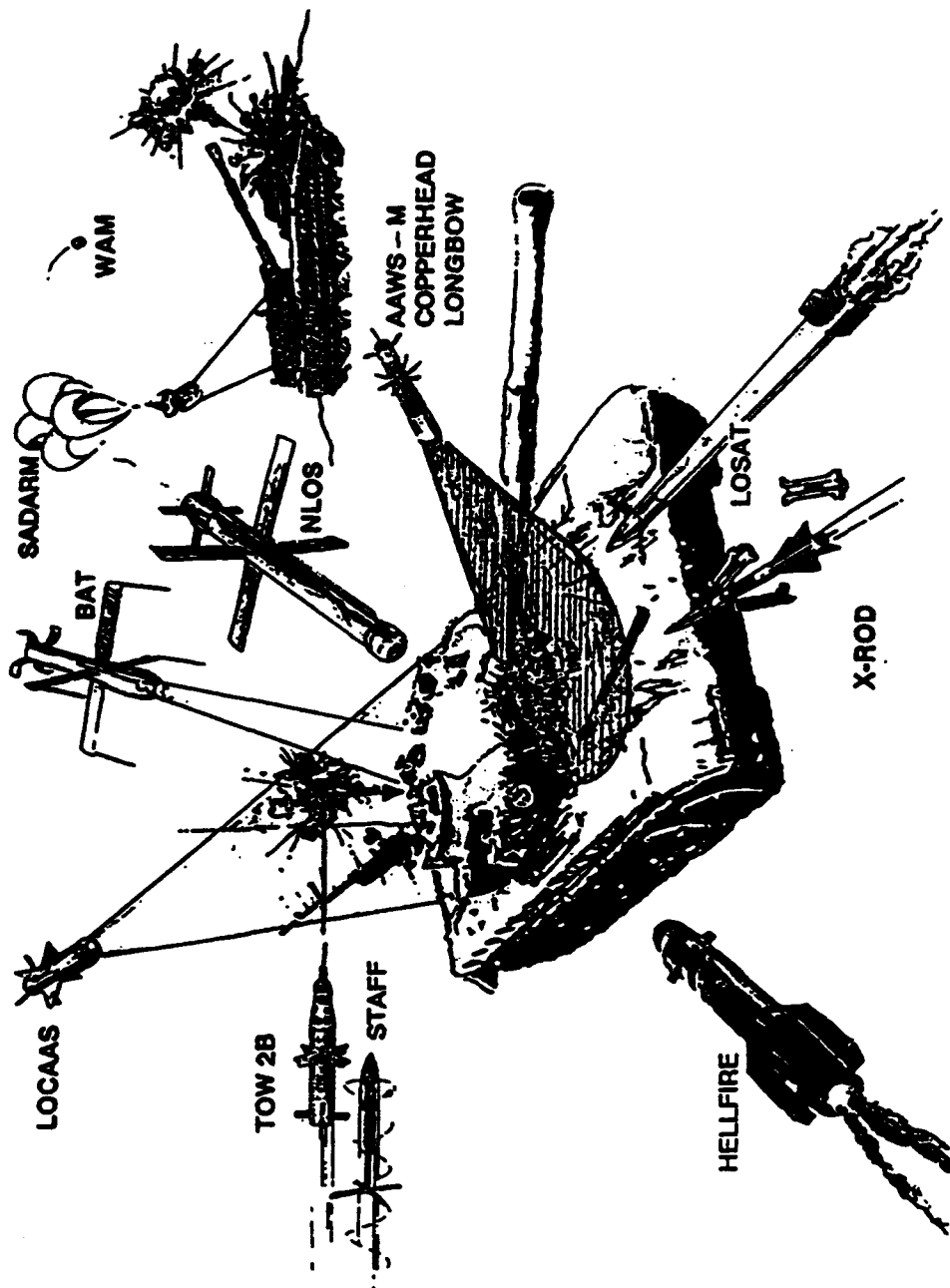
GACIAC SPECIAL TASKS

- TOW 2B - PERFORMANCE AND COUNTERMEASURE TESTING
- SADARM - MODELING/SIMULATION AND COUNTERMEASURE TESTING (CHICKEN LITTLE) AND ASSESSMENT
- WAM - ACOUSTIC ANALYSIS
- STAFF - COUNTERMEASURE ASSESSMENT
- JAVELIN - COUNTERMEASURE ANALYSIS
- HELLFIRE - INDEPENDENT AERODYNAMIC ANALYSIS
- MLRS-TGW - COUNTERMEASURE EFFECTIVENESS ANALYSIS
- BAT P³I - ANALYSIS OF P³I ALTERNATIVES, MODELING AND ANALYSIS OF P³I WITH ATACMS P³I
- NLOS - COUNTERMEASURE ASSESSMENT
- APACHE LONGBOW - COUNTERMEASURE ASSESSMENT
- CHICKEN LITTLE - SMART WEAPONS SENSOR/SEEKER AND COUNTERMEASURE TESTING

GACIAC SPECIAL TASKS PROVIDE TECHNICAL SUPPORT FOR SMART
WEAPON DEVELOPMENTS



ANTI-ARMOR MUNITIONS ATTACK



ADVANCED LAND COMBAT DATABASES

- TARGET SIGNATURE DATABASES
 - TOWER TESTING
 - CAPTIVE FLIGHT
 - SENSOR/SEEKER TYPES
 - ELECTRO-OPTICAL
 - IR
 - MMW
 - DUAL MODE
 - ACOUSTIC
 - LADAR
- COUNTERMEASURE EFFECTS
 - SIGNATURE SUPPRESSION
 - DECOYS
 - OBSCURANTS
 - JAMMING
- AMC-SWMO - IDENTIFIES SIGNATURE REQUIREMENTS
 - ENSURES REPROGRAMMABILITY
- CHICKEN LITTLE - TABILS
- FSTC - THREAT/SCALE MODELS VEHICLES FOR SIGNATURE USE
- ARGUS - DoD INTEGRATION OF SERVICE DATABASES

DATABASES ECONOMICALLY SUPPORT TRI-SERVICE SYSTEM DEVELOPMENT



ADVANCED LAND COMBAT PRODUCTS / VALUE

- GACIAC SUPPORTS AMC-SMART WEAPONS MANAGEMENT OFFICE (AN INTEGRATOR FOR SMART WEAPONS DEVELOPMENT)
 - MANAGES/PRIORITIZES SIGNATURE REQUIREMENTS
 - ENSURES SMART WEAPONS REPROGRAMMABILITY
 - DEVELOPED SMART WEAPONS CM/CCM ASSESSMENT METHODOLOGY
- MODELING/SIMULATION SUPPORTS AND EXPEDITES SYSTEM DEVELOPMENT
- CHICKEN LITTLE ARMY/AIR FORCE JOINT PROGRAM PROVIDES A REALISTIC TEST ENVIRONMENT FOR SMART WEAPONS
- SMART WEAPONS PROVIDE LAND FORCES THE CAPABILITY TO EXECUTE THEIR MISSION RAPIDLY WITH MINIMAL CASUALTIES, SUCH AS IN DESERT STORM

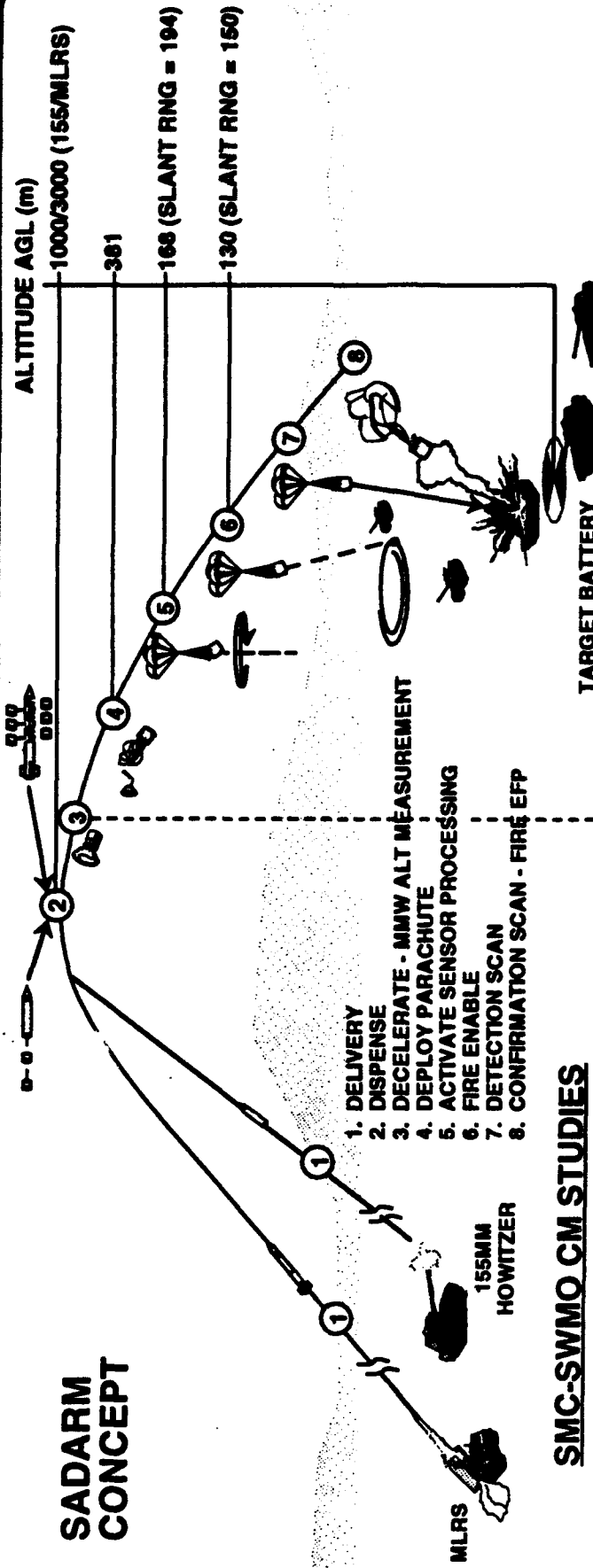
**IN THE ERA OF DECREASED DEFENSE SPENDING, GACIAC PROVIDES
"ECONOMIES OF SCALE" FOR DoD**



UNCLASSIFIED

TACTICAL LAND FORCES CONTEXT SMART WEAPONS COUNTERMEASURE STUDIES

SADARM CONCEPT



SMC-SWMO CM STUDIES

• DESIGNED TO ASSIST SW MATERIEL AND COMBAT DEVELOPERS IN UNDERSTANDING HOW CMs AFFECT SW PERFORMANCE

• CM STUDIES INCLUDE:

- VOLUME I: GUIDE TO HOW COUNTERMEASURES AFFECT SMART WEAPONS
- VOLUME II: EFFECTS OF COUNTERMEASURES ON SMART WEAPON TECHNOLOGY
- VOLUME III: CM/CCM ANALYSIS OF SMART WEAPON SYSTEMS
- VOLUME IV: GUIDE TO ARMY SMART WEAPON TESTING ISSUES

Presented By: DR. NARYAN MURARKA

CM/CCM ANALYSIS OF SMART WEAPON SYSTEMS

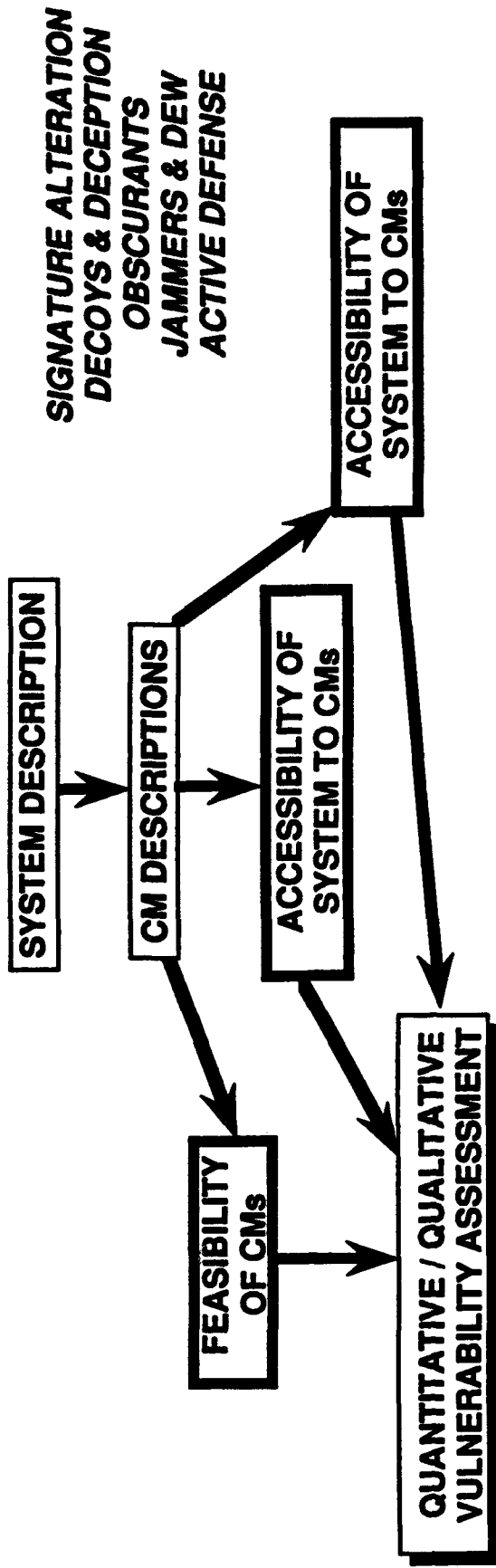
CM VOLUME III CONSISTS OF AN EXECUTIVE SUMMARY AND FIVE INDIVIDUAL SUBVOLUMES

- VOLUME III-A: SENSE AND DESTROY ARMOR (SADARM)
- VOLUME III-B: SMART TARGET-ACTIVATED FIRE-AND-FORGET (STAFF)
- VOLUME III-C: NON-LINE OF SIGHT (NLOS)
- VOLUME III-D: MULTIPLE LAUNCH ROCKET SYSTEM - TERMINAL GUIDANCE WARHEAD (MLRS-TGW)
- VOLUME III-E: GENERIC LADAR ANTI-ARMOR SYSTEM (GLAAS)

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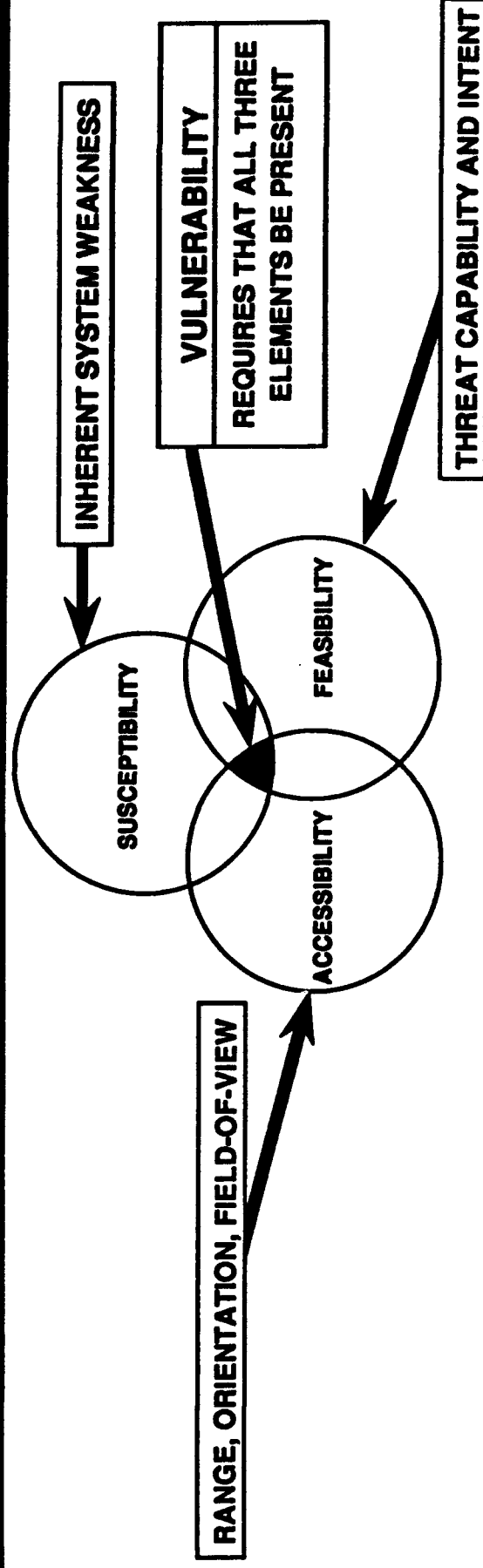
SMART WEAPONS COUNTERMEASURE STUDIES ASSESSMENT METHODOLOGY



- CM/CCM ANALYSIS WAS DESIGNED TO DETERMINE HOW SMART WEAPONS WOULD PERFORM IN A CM ENVIRONMENT
- SYSTEM DESIGN AND INHERENT CCM FEATURES WERE TAKEN INTO ACCOUNT
- A DETAILED LISTING OF CCMs THAT AFFECT THE SYSTEM AND THE NATURE OF THEIR EFFECTS WERE ASSESSED

GACIAC DEVELOPED A CM/CCM ANALYSIS METHODOLOGY FOR ASSESSING SMART WEAPONS VULNERABILITY

SMART WEAPONS COUNTERMEASURE STUDIES SYSTEM VULNERABILITY



- VENN DIAGRAM ILLUSTRATES THE CONCEPT OF INTEGRATING THE KEY ASPECTS OF SYSTEM VULNERABILITY
- SUSCEPTIBILITY IS THE SYSTEM'S INHERENT WEAKNESS
- FEASIBILITY IS AN ASSESSMENT OF THREAT CAPABILITY AND INTENT
- ACCESSIBILITY ADDRESSES THE GEOMETRY OF THE ENGAGEMENT FROM A RANGE, ORIENTATION, FIELD-OF-VIEW

**SYSTEM COUNTERMEASURE VULNERABILITY CAN BE DETERMINED BY
INTEGRATING SUSCEPTIBILITY, FEASIBILITY, AND ACCESSIBILITY**

SMART WEAPONS COUNTERMEASURE STUDIES

COUNTERMEASURES	ELEMENTS / KEY CONSIDERATIONS	RATING
<ul style="list-style-type: none"> • SIGNATURE ALTERATIONS <ul style="list-style-type: none"> • SUPPRESSION • AUGMENTATION • DECOYS / DECEPTION <ul style="list-style-type: none"> • LOW FIDELITY • HIGH FIDELITY • OBSCURANTS <ul style="list-style-type: none"> • CONVENTIONAL • BISPECTRAL • MULTISPECTRAL • JAMMERS / DIRECTED ENERGY WEAPONS <ul style="list-style-type: none"> • JAMMERS • SELF-PROTECT • ESCORT • SEMI • DEW • HIGH ENERGY LASERS • HIGH POWERED MICROWAVE • ACTIVE SELF-PROTECTION 	<ul style="list-style-type: none"> • ELEMENTS <ul style="list-style-type: none"> • SUSCEPTIBILITY • FEASIBILITY • ACCESSIBILITY • VULNERABILITY • KEY CONSIDERATIONS <ul style="list-style-type: none"> • CURRENT CAPABILITY • FUTURE CAPABILITY 	<p>HIGH</p> <p>MODERATE</p> <p>LOW</p> <p>VERY LOW</p>

SMART WEAPONS CM/CCM ASSESSMENT METHODOLOGY PROVIDED

A RIGOROUS APPROACH TO EVALUATE EACH APPLICABLE CM AND FUNCTIONAL CLASS OF CMs

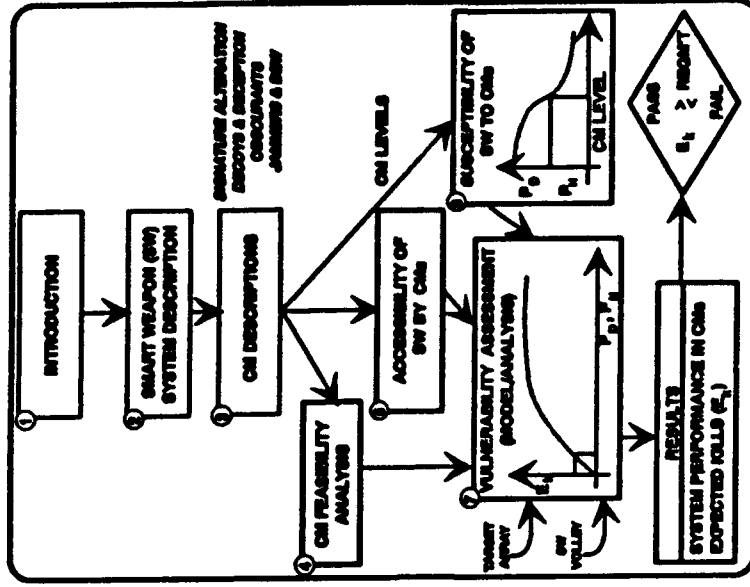
Prepared By **WALTER F. BOUTWELL**

SMART WEAPONS COUNTERMEASURE STUDIES QUALITATIVE/QUANTITATIVE VULNERABILITY ASSESSMENTS

CM	FEASIBILITY	ACCESSIBILITY	SUSCEPTIBILITY	VULNERABILITY
#1	●	●	●	●
#2	●	○	●	○
#3	○	○	●	○
#4	○	○	○	○
#5	○	○	○	○

LEGEND: ● HIGH ○ MODERATE ○ LOW ○ VERY LOW

- SYSTEM VULNERABILITY SHOULD NOT EXCEED THE RATING OF ITS LOWEST ELEMENT AND CAN BE LOWER
- FOR THESE REASONS SYSTEM VULNERABILITY IS USUALLY LESS THAN ITS SUSCEPTIBILITY



DEPENDING ON DEGREE OF SYSTEM MATURITY, EITHER QUALITATIVE JUDGEMENTS ARE MADE OR QUANTITATIVE VULNERABILITY ASSESSMENT MADE WITH TEST/MODELING DATA

Presented by
EXACTAC
DR. N. P. MURRAY

SMART WEAPONS COUNTERMEASURE STUDIES PRODUCTS/VALUE

- FOUR CM VOLUMES WILL ASSIST MATERIEL AND COMBAT DEVELOPERS TO UNDERSTAND HOW CMs AFFECT SMART WEAPON PERFORMANCE
 - VOLUME I: GUIDE TO HOW COUNTERMEASURES AFFECT SMART WEAPONS
 - VOLUME II: EFFECTS OF COUNTERMEASURES ON SMART WEAPON TECHNOLOGY
 - VOLUME III: CM/CCM ANALYSIS OF SMART WEAPON SYSTEMS
 - VOLUME IV: GUIDE TO ARMY SMART WEAPON TESTING ISSUES
- VOLUME III PROVIDES DETAILED CM ASSESSMENTS OF SPECIFIC SYSTEMS/ TECHNOLOGY AND APPLIES THE CM/CCM ASSESSMENT METHODOLOGY
 - VOLUME III-A SENSE AND DESTROY ARMOR (SADARM)
 - VOLUME III-B SMART TARGET-ACTIVATED FIRE-AND-FORGET (STAFF)
 - VOLUME III-C NON-LINE OF SIGHT (NLOS)
 - VOLUME III-D MULTIPLE LAUNCH ROCKET SYSTEM--TERMINAL GUIDANCE WARHEAD (MLRS-TGW)
 - VOLUME III-E GENERIC LADAR ANTI-ARMOR SYSTEM (GLAAS)
- PMs GET THE BENEFIT OF A DETAILED CM ASSESSMENT WHICH EVALUATES THE ROBUSTNESS OF THE SYSTEM TO CMs
 - CCM EFFORTS CAN BE IDENTIFIED FOR FUTURE P3I
 - SYSTEM REPROGRAMMABILITY REQUIREMENTS CAN BE IDENTIFIED TO IMPROVE PERFORMANCE
- RESULTS PUBLISHED IN GACIAC SPECIAL REPORT (GACIAC SR 93-01)

AMC-SWMO HAS A RIGOROUS SMART WEAPON CM/CCM ANALYSIS
METHODOLOGY FOR USE IN ANALYZING OTHER SMART WEAPON SYSTEMS



NTIAC

NONDESTRUCTIVE EVALUATION APPLICATIONS FOR STRATEGIC FORCES AND MISSIONS

Prepared by

**Gary W. Carriveau
Principal Scientist
NTIAC
415 Crystal Creek Drive
Austin, Tx. 78746**

Approved for Public Release: Distribution Unlimited

Prepared by: Gary W. Carriveau

NTIAC - 1

CONTEXT

- **NONDESTRUCTIVE EVALUATION AND INSPECTION OF MATERIALS AND SYSTEMS HAS BEEN IDENTIFIED AS A DOD CRITICAL TECHNOLOGY**
- The objective of this task is to identify NDE methods, associated information collection techniques, and appropriate applications which can be made available to U.S. Special Operations Command, Component Special Operations Forces, and other U.S. Light Infantry Forces

NTIAC TASK FOCUS

- **LIGHT INFANTRY AND SPECIAL OPERATIONS FORCES OF THE DOD ARE OFTEN CALLED UPON TO OPERATE IN FORWARD AREAS WITH LITTLE OR NO LOGISTICAL SUPPORT.**
- **ESTABLISHED NONDESTRUCTIVE EVALUATION METHODOLOGIES MAY PROVIDE IMPORTANT SELF-CONTAINED, PORTABLE, IN-FIELD APPLICATIONS FOR THE COLLECTION OF INFORMATION BEARING ON THE TACTICAL SITUATIONS CONFRONTING THESE FORCES.**
- **NTIAC was requested by the Defense Technical Information Center to perform an assessment of applicable NDE technologies and methodologies**
- **Assistance is to be provided in the form of a technology assessment and method development plan**

NTIAC METHODOLOGY

- **SOF MISSION ANALYSIS WITH REGARD TO POSSIBLE NDE METHODS**
- **SPECIFIC NDE APPLICATIONS FOR TACTICAL INFORMATION COLLECTION**
- **NDE HARDWARE/SOFTWARE REQUIREMENTS ANALYSIS**

Prepared by: Gary W. Carriveau

NTIAC - 4

SUMMARY OF DATA

- **RESULTS OF THE STUDY OF SOF MISSIONS AND POTENTIAL NDE APPLICATION**
- **STUDY OF APPROPRIATE NDE TECHNIQUES/METHODS**
- **REQUIREMENTS ANALYSIS AND TECHNICAL EVALUATION OF SENSORS, INTERFACE, DATA ANALYZERS (HARDWARE AND SOFTWARE), AND COMMUNICATIONS LINKS THAT ARE NEEDED**

ANALYSIS RESULTS

- **SUMMARY REPORT OF SOF MISSIONS AND FUNCTIONS WHERE NDE MAY BE APPROPRIATE**
- **SUMMARY REPORT OF POTENTIAL NDE TECHNIQUES/METHODS**
- **REQUIREMENTS ANALYSIS OF HARDWARE AND SOFTWARE REQUIRED**

Prepared by: Gary W. Cariveau

NTIAC - 6

EXPECTED RESULTS AT THE CONCLUSION OF THIS EFFORT

- **SUMMARY REPORT DESCRIBING POTENTIAL NDE APPLICATIONS IN
SUPPORT OF SOF MISSIONS**
- **REQUIREMENT STATEMENTS FOR NDE DEVELOPMENT IN SUPPORT
OF SOF MISSIONS**
- **IDENTIFICATION OF NDE TECHNOLOGY GAPS THAT MAY REQUIRE
FUTURE SUPPORT**

Prepared by: Gary W. Carriveau

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RELEVANCE TO OTHER USERS

- **RESULTS MAY BE USED TO INCREASE THE BREADTH OF TACTICAL INFORMATION COLLECTION TOOLS AND TECHNIQUES FOR ALL DOD COMPONENTS**
- **RESULTS WILL PROVIDE ADDITIONAL REQUIREMENTS INFORMATION TO DEVELOPERS OF SELF-CONTAINED, PORTABLE, IN-FIELD NDE HARDWARE/SOFTWARE**

Prepared by: Gary W. Carriveau

NTIAC - 8

NTIAC

**NONDESTRUCTIVE TEST/EVALUATION
ASSESSMENT IN SUPPORT OF
TACTICAL LAND FORCES AND
MISSIONS**

Prepared by

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Prepared by: Gary W. Carriveau

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Approved for Public Release: Distribution Unlimited

CONTEXT

- **NONDESTRUCTIVE EVALUATION AND INSPECTION OF MATERIALS AND SYSTEMS HAS BEEN IDENTIFIED AS A DOD CRITICAL TECHNOLOGY**
 - The objective of this task is to benchmark the status of Nondestructive Testing/Evaluation for applicability to the Composite Armored Vehicle (CAV) Advance Technology Demonstrator (ATD)
 - o Users include:
 - Army Tank-Automotive Command and others involved in the development of such a vehicle
 - Other developers of "thick" composite components for vehicles and major assemblies (land, sea, air, space)

NTIAC TASK FOCUS

- **THE NEXT GENERATION COMPOSITE ARMORED VEHICLE CAN BENEFIT FROM A CONCURRENT ENGINEERING APPROACH WHICH INCLUDES NDE AT THE BEGINNING OF DESIGN CONSIDERATIONS**
- **NTIAC was requested by the U.S. Army Tank-Automotive Command to perform a detailed technology assessment on the state-of-the-art of NDE applied to "thick" polymer composites**
- **Assistance was provided in the form of a "study" and laboratory testing**

NTIAC METHODOLOGY

- **ESTABLISH THE BEST STATES OF PRACTICE FOR MATURE AND EMERGING TECHNOLOGIES**
- **DEFINE THE EXTENT THAT THESE TECHNOLOGIES ARE APPLICABLE OR MUST BE MODIFIED TO BE APPLICABLE TO CAV**
- **DEFINE THE SPECIFIC ROLE THAT THE TECHNOLOGIES MAY PLAY IN CAV DESIGN AND ATD FABRICATION**
- **COORDINATE THE TECHNOLOGY ASSESSMENT WITH WORK BEING DONE AT GOVERNMENT LABS, COMPOSITE CONSORTIA, UNIVERSITIES, AND PRIVATE INDUSTRY**

SUMMARY OF DATA

- **BIBLIOGRAPHIC SEARCH OF THE LITERATURE, 300 CITATIONS**
- **COLLECTION OF 148 PAPERS CITED IN THE SEARCH RESULTS, MOST WERE FOUND IN THE NTIAC DATABASE HOLDINGS**
- **DEVELOPMENT OF A "THICK" COMPOSITE DATABASE TO CATALOG AND TRACK PAPERS**
- **INFORMATION/DATA ACQUIRED THROUGH VISITS AND DISCUSSIONS WITH MATERIAL FABRICATORS, SYSTEM MANUFACTURES, TECHNIQUE/INSTRUMENT DEVELOPERS, RESEARCH LABORATORIES**

RESULTS OF ANALYSIS

- FINAL TECHNICAL REPORT FROM "STUDY" PHASE
- IDENTIFICATION OF ADDITIONAL NEED; REQUEST FOR AN EXPANSION OF THE TASK TO INCLUDE LABORATORY ASSESSMENT FOR DIRECT COMPARISON OF PROMISING NDE TECHNOLOGIES
- RECOMMENDATIONS FOR MOST PROMISING NDE FOR APPLICATION TO THE CAV
- NTIAC STATE-OF-THE-ART REPORT

Prepared by: Gary W. Carriveau

NTIAC - 6

EXPECTED RESULTS AT THE CONCLUSION OF THE EFFORT

- **IDENTIFICATION AND ASSESSMENT OF NDE TECHNOLOGY FOR THE
CAV ATD PROGRAM WITH POTENTIAL CONCURRENT ENGINEERING
APPLICATION TO:**
 - Improve combat effectiveness of advanced land vehicles
 - Optimize reduction of vehicle weight/increase reliability
 - Shorten acquisition time through better manufacturing process
control
- **A MUCH BETTER UNDERSTANDING OF NDE APPLIED TO "THICK"
POLYMER COMPOSITES**
- **STATE-OF-THE-ART REPORT**
- **PRESENTATION/PUBLICATIONS**

Prepared by: Gary W. Cariveau

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RELEVANCE TO OTHER USERS

- THE RESULTS WILL BE USEFUL TO ANYONE USING "THICK" COMPOSITES (LAND, SEA, AIR, SPACE) APPLICATIONS
- LABORATORY RESULTS WILL BE USED FOR FURTHER DEVELOPMENT OF NDE TECHNIQUES
- PROCESS CONTROL OF "THICK" COMPOSITES
- REPAIRABILITY & DURABILITY ISSUES

Prepared by: Gary W. Carriveau

NTIAC - 8

THE JOINT LIVE FIRE/LIVE FIRE TEST (JLFLFT) PROGRAM CATALOGUE

Prepared by

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Approved for Public Release: Distribution Unlimited

CONTEXT

- SUPPORT DOD TACTICAL LAND-BASED AIR FORCES AND GROUND FORCES WITHIN THE DOD S & T THRUST AREA OF AIR SUPERIORITY AND ADVANCED LAND COMBAT BY HELPING:
 - To Disseminate Critical Vulnerability/Lethality Data on U.S. and Foreign Air, Ground, and Sea Combat Systems
 - To Serve as a Compilation of Test Program Data and Reports

JOINT LIVE FIRE/LIVE FIRE TEST PROGRAM CATALOGUE

- **DOD S & T THRUST**
 - **Air Superiority, Advanced Land Combat**
- **SURVIAC TASK FOCUS**
 - **Identify and Verify All JLF/LFT Tests and Test Reports**
 - **Develop and Distribute Initial Catalogue**
 - **Update and Distribute Annual Revisions**

SURVIAC METHODOLOGY

- **METHODOLOGY USED TO PERFORM WORK**
 - **Reviews of JLF/LFT Test Plans**
 - **Interviews with JLF Test Planners**
 - **Searches for Published JLF/LFT Test Reports**
 - **Follow-Up Interviews with JLF/LFT Test Planners to Identify Unpublished Test Plans and Reports**
- **APPROACH**
 - **Apply First-Hand Knowledge of Information to be Included in the JLF/LFT Catalogue**
 - **Focus on Published JLF/LFT Test Plan Books, Reports, and Newsletter Articles**
 - **Use a Database to Compile and Organize All Information Obtained and for Rapid Access**

SUMMARY OF DATA

- **DATA COLLECTED**
 - **All Currently Available Data on JLF/LFT Programs**
- **DATA CHARACTERISTICS**
 - **Covers all Data Parameters Required by Analysts Within the JLF/LFT Community**
 - **Comprehensive Source of Air and Ground Ballistic Live Fire Test Data and Test Reports from Both the JLF and LFT Communities**

RESULTS OF DATA ANALYSIS

- **FINDINGS SYNTHESIZED BY SURVIAC**
 - **Allows the Test Community to Identify Tests that have Already Been Performed to Eliminate Duplicate or Redundant Tests**
 - **Provides a Comprehensive Source of Test Information that can be Used to Enhance or Verify Future Test Plans, Approaches, or Test Results**
 - **Only Lists JLF/LFT Test Information; Does Not Provide Advice/Recommendations**
- **SUMMARY OF TECHNICAL RECOMMENDATIONS**
 - **Continue to Update and Reissue the Catalogue as New Tests are Proposed and Current Tests are Completed**

CONSEQUENCES

- **WHAT HAS HAPPENED AS A RESULT OF COMPLETION OF THIS SURVIAC PRODUCT**
 - **Financial Benefits to DoD**
 - Avoids Duplication of Test Efforts
 - Provides a Source for Baseline Cost Estimates When Developing Similar Test Programs
 - Illustrates Test Plan Approaches to Address Varied Test Objectives
 - **Other Benefits to DoD**
 - Shows the Cost and Technical Variations Associated with Testing Actual Hardware, Mockups, and Replica Test Articles
 - Establishes a Model for Possible Transition to Civilian Aircraft Safety, Crash and Terrorist Bomb Incident Information
 - **Changes in DoD Operations, Plans, or Procedures as a Direct Result of Product**
 - More Efficient Live Fire Test Planning and Execution Process

RELEVANCE TO OTHER USERS

- **FEDERAL AVIATION ADMINISTRATION**
- **AUTOMOBILE MANUFACTURERS**
- **CIVILIAN AIRLINER MANUFACTURERS**



SURVIVABILITY SYSTEMS MASTER PLAN

Prepared by

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Approved for Public Release: Distribution Unlimited

CONTEXT

- SUPPORT THE DOD MILITARY GROUND FORCES WITHIN THE S & T THRUST AREA OF ADVANCED LAND COMBAT BY HELPING:
 - To Describe the Army's Plan for Achieving Survivability for Ground Combat Vehicles
 - To Provide a Source for Information on Developments in Ground Combat Vehicle Survivability

SURVIVABILITY SYSTEMS MASTER PLAN

- **DOD MILITARY MISSIONS/FUNCTIONS**
 - **Advanced Land Combat**
- **SURVIAC TASK FOCUS**
 - **Document How the Program Manager Survivability Systems (PM-SS) Fits in Army Acquisition Programs**
 - **Publicize DoD Acquisition Plans and the Role of PM-SS**

SURVIAC METHODOLOGY

- **METHODOLOGY USED TO PERFORM WORK**
 - **Consolidate Information on Technical Programs**
 - **Provide Consistency with DoD Acquisition Regulations**
- **APPROACH**
 - **Review and Evaluate Approaches on Previous Master Plans**
 - **Compile Programmatic Information, e.g., Cost, Performance, Technical Content**
 - **Interview Organizations Doing Technical Work on PM-SS Programs**
 - **Develop Methodology on How PM-SS Provides Information for New Programs**

SUMMARY OF DATA

- **DATA COLLECTED**
 - **Technical Program Details**
 - **Programmatic Plans**
 - **Materiel Acquisition Procedures**
- **DATA CHARACTERISTICS**
 - **Detailed Data on Individual Programs**
 - **Thrust Data to Reveal Overlaps and Voids**

RESULTS OF DATA ANALYSIS

- **FINDINGS SYNTHESIZED BY SURVIAC**
 - **Identified Data Gaps in Overall Program Areas**
 - **Aligned Programs with Program Milestones**
- **SUMMARY OF TECHNICAL RECOMMENDATIONS**
 - **Prepare Annual Updates**
 - **Continue to Disseminate Information on PM-SS Initiatives Through a Newsletter**

CONSEQUENCES

- **WHAT HAS HAPPENED AS A RESULT OF COMPLETION OF THIS SURVIAC PRODUCT**
 - **Financial Benefits to DoD**
 - o Some Programs Were Rescoped, Reduced, or Eliminated
 - **Other Benefits to DoD**
 - o Roadmap for PM-SS Technical Program and Information Resources Is Available for Others
 - **Changes in DoD Operations, Plans, or Procedures as a Direct Result of Product**
 - o More Efficient Use of Critical Program Resources
 - o Enhanced Dissemination of Planned and On-Going Programs

RELEVANCE TO OTHER USERS

- **INFORMATION DISSEMINATION APPROACH
APPLICABLE TO OTHER DOD ORGANIZATIONS
CONDUCTING MULTIPLE, INTERRELATED PROGRAMS**

A NOTIONAL INDIVIDUAL FIGHTING SYSTEM

Prepared by

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and

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Approved for Public Release: Distribution Unlimited

[The final report for this study is Limited Distribution and/or Classified.]

CONTEXT

- THE JOINT SERVICE SMALL ARMS PROGRAM OFFICE SOUGHT TO IDENTIFY DEVELOPING SYSTEMS THAT WOULD LOGICALLY FORM A PART OF AN INDIVIDUAL FIGHTING SYSTEM
- Identify long term technological development efforts with emphasis on:
 - Survivability - improved capability of individual combatant
- Not inhibited by requirements
- Examine how identified technologies may be merged into components and systems to yield an "Individual Fighting System"

Prepared by: B. J. Tullington-Battelle/
L. W. Williams-TWSTIAC

TWSTIAC-2

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TWSTIAC INFORMATION PRODUCT

- **DoD S&T THRUST 5: ADVANCED LAND COMBAT**
- **DoD MILITARY MISSIONS/FUNCTIONS: GROUND FORCES/INFANTRY SYSTEMS**
- **IAC FOCUS: 21ST CENTURY LAND WARRIOR ATDS/TD**
 - Identify related research and development projects and determine scope of the programs, objective, technical feasibility, and time schedule
 - Conceptualize a workable Individual Fighting System
 - Develop a management plan to ensure that the applicable technologies are sufficiently mature when needed

Prepared by: B. J. Tullington-Battelle/
L. W. Williams-TWSTIAC

TWSTIAC-3

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TWSTIAC METHODOLOGY

- **METHODOLOGY**
 - **Data collection to identify related projects**
 - **Visits to program office to update information and discuss programs/problems and potential of ongoing research**
 - **Analysis of findings to assess potential of various projects**
- **APPROACH**
 - **Reviewed related TWSTIAC efforts as starting point**
 - **Future individual weapon concepts**
 - **Future alternative concepts**

**Prepared by: B. J. Tullington-Battelle/
L. W. Williams-TWSTIAC**

TWSTIAC-4

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TWSTIAC METHODOLOGY

(Continued)

- **Site visits to National Labs and RD&E Centers to discuss ongoing projects -- to include:**
 - **LANL - Project Pitman**
 - **CECOM - Infantryman's Integrated Sensor System**
 - **Natick RD&E Center - Protective Equipment**
 - **Center for Night Vision - Display Devices**
 - **ARDEC - Advanced Infantry Weapons**
- **Conducted brainstorming workshops to identify likely components and system, and to assess the utility and feasibility of the concepts**
- **Identified activity proponency for system areas**
- **Outlined a plan to track technology development**

**Prepared by: B. J. Tullington-Battelle/
L. W. Williams-TWSTIAC**

TWSTIAC-5

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SUMMARY OF DATA

- DATA COLLECTED

- Information on projects that could impact:

- Life Support Systems: Rebreather, positive overpressure, lightweight armor, low observable shell, body function monitors
 - Fire Control Systems: GPS/NAV systems, force feedback to control exoskeleton, holographic heads up displays
 - Weaponization: Personal defense weapon, launched long range, terminal homing and variable effects weapon
 - Power Supply: Fuel cell, high density fuel storage

Prepared by: B. J. Tullington-Battelle/
L. W. Williams-TWSTIAC

TWSTIAC-6

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RESULTS OF DATA ANALYSIS

- **FINDINGS RESULTING FROM ANALYSIS OF TWSTIAC DATA**
 - **A notional fighting system was described by systems and components, that if brought to fruition would yield a fighting system without parallel in the world**
 - **Sixteen components were identified that make up the system along with various periods for development and identification of the proponent organizations**
 - **Actions by JSSAP were suggested**

**Prepared by: B. J. Tullington-Battelle/
L. W. Williams-TWSTIAC**

TWSTIAC-7

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CONSEQUENCES

- THIS EFFORT BROUGHT THE NOTION OF AN INDIVIDUAL SOLDIER AS A "FIGHTING SYSTEM" DESERVING ATTENTION SIMILAR TO OTHER COMBAT SYSTEMS.
- THE SOLDIER IMPROVED PROTECTIVE ENSEMBLE (SIPE) PROGRAM IS A DIRECT SPINOFF FROM THIS EFFORT. THIS ONGOING EFFORT BY NATICK RD&E CENTER IS DEMONSTRATING SEVERAL OF THE IFS COMPONENTS, TO INCLUDE:
 - Integrated computer aided location and helmet display
 - Protective equipment
 - Exoskeleton development

Prepared by: B. J. Tullington-Battelle/
L. W. Williams-TWSTIAC

TWSTIAC-8

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RELEVANCE TO OTHER USERS

- Natick RD&E Center: "...Impression of this report is very positive...the inclusion of the exoskeleton in the concept identified in the Battelle report goes a significant step beyond the Natick Notional System..."
- HEL: After using this analysis to evaluate a proposed concept noted: "...the Battelle report provided much of the information required for our review...In general, NRDEC...was very positive on the concept."

Prepared by: B. J. Tullington-Battelle/
L. W. Williams-TWSTIAC

TWSTIAC-9

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**EVALUATION OF CANDIDATE WARHEADS
AGAINST CHEMICAL TARGETS FOR PATRIOT PAC-3**

Prepared by

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and

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Approved for Public Release: Distribution Unlimited

[The final report for this study is Limited Distribution and/or Classified.]

CONTEXT

- **DoD S&T THRUSTS 3 AND 5: AIR SUPERIORITY AND DEFENSE
ADVANCED LAND COMBAT**

**" ... To defend deployed military forces... From... Ballistic...
Missiles... Require(s) a strong effort in missile defense..."**

- **DoD KEY TECHNOLOGIES: ENERGY CONVERSION AND STORAGE**

**Prepared by: R. G. Mapes-Battelle/
L. W. Williams-TWSTIAC**

TWSTIAC-2

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TWSTIAC OBJECTIVE

- **EVALUATE THE EFFECTIVENESS OF A PATRIOT PAC-3 WARHEAD CANDIDATE AGAINST A SRBM DELIVERED CHEMICAL SUBMUNITION PAYLOAD**
- **THIS PROGRAM SUPPORTS THE DoD S&T THRUSTS ON ADVANCED LAND COMBAT AND AIR SUPERIORITY AND DEFENSE**

Prepared by: R. G. Mapes-Battelle/
L. W. Williams-TWSTIAC

TWSTIAC-3

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TWSTIAC PRODUCT

- **TWSTIAC WAS ASKED TO PROVIDE DATA FOR A SPECIFIC WARHEAD AND SPECIAL THREAT TACTICAL MISSILE CHEMICAL PAYLOAD**
- **THE PATRIOT PROJECT OFFICE REQUIRED DEMONSTRATED WARHEAD LETHALITY DATA AGAINST TACTICAL MISSILE CHEMICAL TARGETS**
- **TWSTIAC DATA GATHERING PROGRAM CONSISTED OF 2 PARTS**
 - **A high fidelity test article development using the threat description in the TWSTIAC Data Base**
 - **An experimental program to collect, analyze, and document warhead/target interaction**

Prepared by: R. G. Mapes-Battelle/
L. W. Williams-TWSTIAC

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TWSTIAC METHODOLOGY

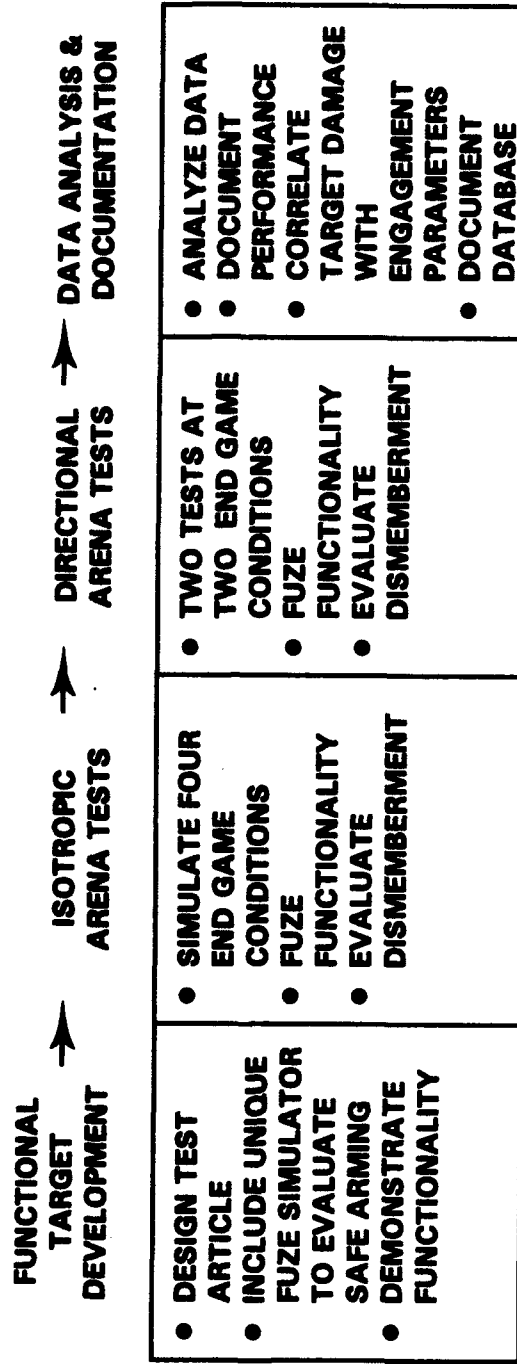
- **DEVELOP AND DEMONSTRATE A HIGH FIDELITY, FUNCTIONAL TEST ARTICLE**
- **USE THIS TEST ARTICLE IN A SERIES OF WARHEAD/TARGET ARENA TESTS TO CHARACTERIZE THE TARGET DAMAGE EFFECTIVENESS OVER A NOMINAL RANGE OF PATRIOT END GAME PARAMETERS**

Prepared by: R. G. Mapes-Battelle/
L. W. Williams-TWSTIAC

TWSTIAC-5

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APPROACH



Prepared by: R. G. Mapes-Battelle/
L. W. Williams-TWSTIAC

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SUMMARY OF DATA

- **DATA COLLECTED**

- **Functional Tests**

- Central burster performance
- Dispersion pattern
- Fuze arming
- Fuze dudding

- **Isotropic Warhead and Directional Warhead Tests**

- Structural dismemberment
- Submunitions penetrated (killed)
- Submunitions damaged
- Submunitions surviving
- Fuzes armed
- Fuzes dudded
- Central burster damage
- Target damage sensitivity to miss distance

Prepared by: R. G. Mapes-Battelle/
L. W. Williams-TWSTIAC

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SUMMARY OF DATA

(Continued)

- **THESE STATIC TEST DATA WERE CORRELATED WITH SLED TEST
DYNAMIC DATA TO ALLOW PREDICTION OF LETHALITY UNDER
ENGAGEMENT CONDITIONS**

Prepared by: R. G. Mapes-Battelle/
L. W. Williams-TWSTIAC

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RESULTS OF DATA ANALYSIS

- **FINDINGS**

- The evaluated warhead demonstrated the potential to increase the lethality of the Patriot PAC-3 Missile against the chemical submunition

- **TECHNICAL ADVICE/RECOMMENDATIONS**

- Recommendations for fragment pattern optimization were made
- Miss distance sensitivity was identified
- Additional kill mechanisms were validated

Prepared by: R. G. Mapes-Battelle/
L. W. Williams-TWSTIAC

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CONSEQUENCES

- **THE FINDINGS AND DATA COLLECTED IN THESE TASKS WILL DIRECTLY SUPPORT THE DAB PROCEEDINGS**
- **INCREASED EFFECTIVENESS OF A MAJOR AIR DEFENSE SYSTEM IN THE TMD ROLE WAS DEMONSTRATED**

Prepared by: R. G. Mapes-Battelle/
L. W. Williams-TWSTIAC

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RELEVANCE TO OTHER USERS

- **THESE DATA WILL BE MADE AVAILABLE TO THE US ARMY SPACE AND STRATEGIC DEFENSE COMMAND/SURVIVABILITY LETHALITY AND KEY TECHNOLOGIES (USASD/C/SLKT) LETHALITY DATA BASE AND WILL SUPPORT THE DEVELOPMENT OF LETHALITY CRITERIA FOR THEATRE HIGH ALTITUDE AREA DEFENSE SYSTEMS (THAADs), EXTENDED RANGE INTERCEPTOR (ERINT) AND CORPS SURFACE-TO-AIR-MISSILE (CORPS SAM), WHICH MUST ENGAGE THIS TARGET**
- **THE DATA WILL BE USED TO VALIDATE AN END GAME LETHALITY MODEL TO PREDICT ENGAGEMENT EFFECTIVENESS**

Prepared by: R. G. Mapes-Battelle/
L. W. Williams-TWSTIAC

TWSTIAC-11

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**TWSTIAC CASUALTY REDUCTION MODELING
FOR THE
NATICK RD&E CENTER**

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[The final report for this study is Limited Distribution and/or Classified.]

CONTEXT

- **DoD S&T THRUSTS 5 AND 6: ADVANCED LAND COMBAT SYNTHETIC ENVIRONMENTS**
 - To develop and field land warrior system equipment which improves warrior lethality and survivability
 - DoD S&T Thrust 5: 21st Century Land Warrior (21 CLW) Top Level Demonstration (TLD)
 - Generation II Soldier Advanced Technology Demonstration (ATD)
 - Development of casualty assessment methodologies
 - Development of warrior performance methodologies
 - Development of dismounted warrior distributed
- **DoD MILITARY MISSION/FUNCTIONS: GROUND FORCES/INFANTRY SYSTEMS**

Prepared by: J. A. O'Keefe-Natick/
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L. W. Williams-TWSTIAC

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TWSTIAC TASK/BASIC INFORMATION PRODUCT

TWSTIAC WAS ASKED TO:

- **REVIEW AND COMPARE CASUALTY REDUCTION ANALYSIS
METHODOLOGIES**
- **INSTALL NEW MUNITIONS CHARACTERISTICS (ARTILLERY,
MORTAR, HAND GRENADE, FLECHETTES, MINES, BOMBS,
MISSILES)**
- **DETERMINE THREAT EFFECTS OF MUNITIONS**
- **ASSESS HEAT STRESS AND MOBILITY REDUCTION OF
EQUIPMENT**
- **DOCUMENT CASUALTY REDUCTION METHODOLOGY**

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TWSTIAC-3

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TWSTIAC METHODOLOGY

- **METHODOLOGY USED TO PERFORM WORK**
 - **Literature search**
 - **Data analysis**
 - **Data synthesis**
- **APPROACH**
 - **Provided experienced ballisticians**
 - **Created new munition tables for ballistic casualty assessment models**
 - **Developed graphic presentation routines for ballistic casualty assessment models**
 - **Developed metabolic work inputs for integrated soldier and small unit performance simulation**

Prepared by: J. A. O'Keefe-Natick/
F.E. Dean-Battelle/
L. W. Williams-TWSTIAC

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ASSISTANCE DELIVERED

- **PRE-AND POSTPROCESSORS TO EASE INPUT AND GRAPHICALLY DISPLAY OUTPUT**
- **METHODOLOGIES REVIEWED AND DOCUMENTED**
- **NEW MUNITION CHARACTERISTICS ADDED TO INPUT DATA LIBRARIES**
- **LETHAL AREA EFFECTS ANALYZED**
- **HEAT STRESS DUE TO ADDITION OF BODY ARMOR TO MOPP IV CONFIGURATION ANALYZED**

Prepared by: J. A. O'Keefe-Natick/
F.E. Dean-Battelle/
L. W. Williams-TWSTIAC

TWSTIAC-5

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RESULTS OF DATA ANALYSIS

- **FINDINGS RESULTING FROM THE ANALYSIS OF DATA COLLECTED BY TWSTIAC**

- Additional research is required to correct the underlying methodologies upon which JTCGE-ME ballistic casualty assessment methodologies are based
- Additional research is required to develop a dismounted soldier protocol data unit for DIS

- **SUMMARY OF TECHNICAL RECOMMENDATIONS**

- Additional research to modify the existing ballistic casualty assessment methodologies to allow assessment of non-uniform ballistic protection

Prepared by: J. A. O'Keefe-Natick/
F.E. Dean-Battelle/
L. W. Williams-TWSTIAC

TWSTIAC-8

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CONSEQUENCES

- **WHAT HAS HAPPENED AS A RESULT OF COMPLETION OF TWSTIAC PRODUCTS?**
 - **Financial benefits to DoD**
 - **Automated tools to support selection of new materials for ballistic protection**
 - **Reduced cost for execution of automated tools**
 - **Other benefits to DoD**
 - **Development of ballistic casualty methodologies for incorporation in integrated soldier simulations**
 - **Development of metabolic work methodologies for inclusion in DIS Soldier System Simulations**

Prepared by: J. A. O'Keefe-Natick/
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TWSTIAC-7

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RELEVANCE TO OTHER USERS

- **RELATED OR ANALOGOUS SUBSTANTIVE PROBLEMS FOR WHICH TWSTIAC PRODUCT WOULD BE RELEVANT**
 - **Ballistic casualty assessment models are in use by AMSAA, Dismounted Warfighting Battle Laboratory, and IDA**
- **RELATED OR ANALOGOUS PROBLEMS FOR WHICH THE TWSTIAC PRODUCT WOULD BE RELEVANT BECAUSE OF THE DATA OR METHODOLOGY USED**
 - **Assessment of the combined casualty effects of chemical fragmentation munitions**
 - **Realistic casualty modeling for dismounted individuals in virtual reality and DIS simulations**

Prepared by: J. A. O'Keefe-Natick/
F.E. Dean-Battelle/
L. W. Williams-TWSTIAC

TWSTIAC-8

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SYNTHETIC ENVIRONMENTS

**CHEMICAL WARFARE COUNTER PROLIFERATION
COMPUTERIZED DECISION AID**

Prepared by

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Approved for Public Release: Distribution Unlimited

CONTEXT

- **ARMS CONTROL**
 - **Counter Proliferation**
 - **Chemical Weapons**
 - **Resources and Technologies Necessary to Develop Chemical Weapons**

IAC TASK

- **WHY**
 - **Intelligence Analysts Need Tools for Timely Analysis of Potential Chemical Warfare Production Sites**
- **WHAT**
 - **Develop Computerized Decision Aid to Depict Visual Signatures of Chemical Warfare Agent Production Sites based on Technology**
- **WHO**
 - **U.S. Army Foreign Science and Technology Center (A Component of the U.S. Army's Intelligence and Security Command)**

IAC METHODOLOGY

- **USE BASIC CHEMISTRY AND PRODUCTION STANDARDS**
- **BUILD DATABASES**
- **DEVELOP/OBTAIN AND INTEGRATE ANALYSIS AND SPECIAL DESIGN SOFTWARE TO APPLY ENGINEERING STANDARDS AND MANIPULATE DATA**
- **DEVELOP GRAPHICAL USER INTERFACE (GUI) TO DEPICT VISUAL SIGNATURES OF CHEMICAL WARFARE AGENT PRODUCTION SITES**

Prepared by: Dr. Susan Brown, et al

CBIAC - 4

SUMMARY OF DATA

- **CHEMICAL REACTION PROCESS DATA TO INCLUDE**
 - **Reaction Chemistry**
 - **Feedstocks**
- **ENGINEERING PRACTICES AND TECHNOLOGIES OF COUNTRIES OF INTEREST**
 - **Equipment**
 - **Feedstocks (available/unavailable)**
 - **Infrastructure**
 - **Weaponization Capabilities**
- **QUANTITIES OF AGENT PRODUCED**

RESULTS

- **OPERATIONAL PROTOTYPE DEVELOPED AND DEMONSTRATED**
 - **Nerve Agents**
 - **Multi - Country Data**

Prepared by: Dr. Susan Brown, et al

CBIAC - 6



CONSEQUENCES

- **FILLS CRITICAL CAPABILITY VOID**
- **IMPROVES TIMELINESS AND QUALITY OF SITE ASSESSMENTS**
- **PROVIDES CAPABILITY TO EVALUATE ALTERNATE SCENARIOS**
- **PROVIDES CAPABILITY TO ACCOUNT FOR CHANGE IN**
 - **Production Levels**
 - **Technological Capabilities**
 - **Engineering Practices**

OTHER POTENTIAL APPLICATIONS

- **TRAINING AND PREPARATION OF INSPECTION TEAMS**
- **DESIGN ENGINEERS IN CHEMICAL PROCESS INDUSTRY**

DESIGN AND ANALYSIS OF A LOW SPEED DRAG PLOW FOR DEEP SNOW

Presented by

**Peter D. Smallidge
CECRL-ORTA**

Authored by

**Michael R. Walsh, CECRL-TE, and Paul W. Richmond, CECRL-EA
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Approved for Public Release: Distribution Unlimited

CONTEXT

- DOD MILITARY MISSIONS / FUNCTIONS
 - Ground Forces
 - » Mobility, Logistics, and Supply
 - Force projection
 - Low intensity conflict

Prepared by: P. D. Smallidge

IAC PLOW-1

IAC TASK / BASIC INFORMATION PRODUCT

- **USER PROBLEM / REQUIREMENT**

- Winter logistics operations for Army field units in Alaska hampered by deep snow
- Existing equipment:
 - » 2-1/2 ton truck
 - » HMMWV
 - » SUSV
- Develop snow clearing device for support off-road winter exercises with wheeled vehicles

- **IAC PRODUCT FOCUS**

- Review snow handling options
- Evaluate snow / terrain conditions
- Literature and patent search on plow technology

SUMMARY OF FINDINGS

- **SNOW HANDLING OPTIONS**
 - **Compaction**
 - **Blowing / throwing**
 - **Melting**
 - **Plowing**
- **SNOW / TERRAIN CHARACTERISTICS**
 - **Low density snow, 1 meter deep**
 - **Terrain is uneven with brush, hummocks, and fallen trees**
- **PLOW TECHNOLOGY**
 - **V-Shaped drag plow**
 - **SUSV adaptable to plow technology**

Prepared by: P. D. Smallidge

IAC PLOW-3

CONSEQUENCES

- **LABORATORY AND MODEL STUDIES TO DEVELOP PLOW AND TOW MECHANISM DESIGNS**
- **FIELD EVALUATION OF HALF AND FULL-SCALE MODELS**
 - Snow depths to 1 meter
 - Within SUSV operating parameters
- **PATENTS ON PLOW AND TOWING MECHANISMS**

RELEVANCE TO OTHER USERS

- **TOWED SLEDS**

- SUSV in Alaska
- Challenger in Antarctica
- Soft ground / marshes

- **FARMING APPLICATIONS**

Prepared by: P. D. Smallidge

IAC PLOW-5

OBSERVATIONS OF ACOUSTIC SURFACE WAVES PROPAGATING ABOVE A SNOW COVER

Presented by

**Peter D. Smallidge
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Authored by

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Approved for Public Release: Distribution Unlimited

CONTEXT

- **DOD KEY TECHNOLOGY**
 - Environmental Effects: The automated generation of near-real-time environmental tactical decision aids to determine the adverse effects of dynamic battlefield environments on characterization and modeling of military requirement and operations.
- **DOD SCIENCE AND TECHNOLOGY THRUST**
 - Precision Strike: Against critical mobile and fixed targets in all-weather; day/night; and foliage- and camouflage-resistant environments.
- **DOD CRITICAL TECHNOLOGY**
 - Signal and Image Processing
 - » Combination of computer architecture, algorithms, and microelectronic signal processing devices for near real-time automation of detection, classification, and tracking of targets.
 - Weapon System Environment
 - » A detailed understanding of the natural environment and its influence on weapons system design and performance.

IAC TASK / BASIC INFORMATION PRODUCT

- **TECHNICAL ISSUE**

- Seismic and acoustic waves are useful for non-line-of-sight surveillance and targeting , but are greatly affected by ground conditions, especially in cold regions (snow, ice, frozen ground).

- **IAC PRODUCT FOCUS**

- Literature search on acoustic coupling processes
- Survey of acoustic modeling concepts for porous media
- Analysis of relevant approaches to simulate effects of snow cover
- Customers: U.S. Army Engineer School; U.S. Army Armament RD&E Center

Prepared by: P. D. Smallidge

IAC-ACOU-2

SUMMARY OF FINDINGS

- **RESEARCH OBJECTIVE**

- Gain an understanding of winter environmental effects on seismic and acoustic waves.
- Develop predictive capabilities applicable to NLOS surveillance and targeting systems.

- **RESEARCH APPROACH**

- Combine experimental, theoretical and computational approaches to understand and predict winter impact on seismic and acoustic waves.

- **SURVEY FINDINGS**

- Little understanding of:
 - » Dominant propagation modes
 - » Critical properties (wave speed, attenuation rate)
 - » Controlling environmental parameters
- Blot's Theory offers analysis approach

CONSEQUENCES

- **RESULTS**

- High attenuation rates for atmospheric acoustic waves above snow covers.
- Theoretical definition of dominant energy propagation modes in porous media.
- Permeability is controlling factor.
- Practical model developed to predict signal characteristics for varying environmental conditions.

- **IMPACT**

- Ability to predict ground sensor performance for a wide range of conditions.
- Applicable to future NLOS sensor development and current systems such as Wide Area Mine.

RELEVANCE TO OTHER USERS

- **PHYSICAL SECURITY SYSTEMS**
 - Sensor performance, design, and evaluation
- **ENVIRONMENTAL QUALITY**
 - Noise abatement predictions

Prepared by: P. D. Smallidge

IAC-ACOU-5

SHIP SUPERSTRUCTURE ICING

Presented by

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Authored by

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Approved for Public Release: Distribution Unlimited

CONTEXT

- **DOD KEY TECHNOLOGY**
 - **Environmental Effects:** The automated generation of near-real-time environmental tactical decision aids to determine the adverse effects of dynamic battlefield environments on characterization and modeling of military requirement and operations.
- **DOD SCIENCE AND TECHNOLOGY THRUST**
 - Sea control and undersea superiority. The need to maintain an overseas presence and operate in littoral zones in a broad range of environmental conditions.
- **DOD CRITICAL TECHNOLOGY**
 - Simulation and Modeling

IAC TASK / BASIC INFORMATION PRODUCT

- **RESEARCH OBJECTIVE:**
 - Allow vessels to avoid hazardous conditions or to minimize the accretion of ice by predicting:
 - » Environmental conditions under which icing may occur
 - » Icing rates
 - » Predominant icing locations on the vessel
- **IAC PRODUCT FOCUS**
 - Survey and analyze existing ship spray icing models
 - Evaluate available data on ship icing
 - Customer: U.S. Navy David W. Taylor Naval Ship Research Center

SUMMARY OF DATA

- **MODELS**
 - Most are empirical and based on trawler data
 - Do not consider the physical processes they simulate
 - Cannot be transferred to larger ships
 - University of Alberta numerical ship icing model
- **DATA**
 - Lack of data on large ship icing

CONSEQUENCES

- **RESEARCH EFFORTS**
 - Calibration and validation of Alberta model
 - Development and evaluation of spray and ice measurement equipment
 - Research cruise USCGC Midget
- **RESULTS**
 - Good video and weather data
 - Partial success on automated spray and icing measurements
 - Sufficient data to verify Alberta model for Navy

RELEVANCE TO OTHER USERS

- **OTHER DIRECT APPLICATIONS**
 - Shoreline / coastal facilities
 - » Logistics over the shore
 - » Coastal radar / communications facilities
 - » Offshore oil platforms
 - Commercial fishing and shipping
- **SPINOFFS**
 - Shipboard instrumentation lessons learned

**SMART WEAPONS OPERABILITY
ENHANCEMENT (SWOE) PROGRAM**

Presented by

**Peter D. Smallidge
CECRL-ORTA**

Program Manager

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Approved for Public Release: Distribution Unlimited

CONTEXT

- **DOD SCIENCE AND TECHNOLOGY THRUST**
 - Synthetic Environments: Provide computer- and electronics-based technology for development, testing, training and readiness to synthesize factory-to-battlefield environments.
 - Precision Strike: Against critical mobile and fixed targets in all-weather; day/night; and foliage- and camouflage-resistant environments.
- **DOD KEY TECHNOLOGY**
 - Environmental Effects: The automated generation of near-real-time environmental tactical decision aids to determine the adverse effects of dynamic battlefield environments on characterization and modeling of military requirement and operations.
- **DOD CRITICAL TECHNOLOGY**
 - Simulation and Modeling
 - Weapon System Environment

IAC TASK / BASIC INFORMATION PRODUCT

- **ARMY TECHNOLOGY BASE MASTER PLAN**
 - Science and Technology Objective, VI.C.5., Smart Weapons Operability Enhancement
 - » Develop analytical IR and MMW models to robustly simulate geographical and time/weather driven character of environmental scenes.
 - » Develop validated multi-sensor scene generation capability for quantitative consideration of environmental conditions in the design, test and evaluation of smart weapon and ATR devices.
- **IAC PRODUCT FOCUS**
 - Survey and analyze environmental science technologies to support development of an integrated, physics based, scene generation process.
 - » Measurement and Information Bases
 - » Analytical Models
 - » Scene Rendering Software
 - Customer:
 - » OSD Joint Test & Evaluation Program
 - » U.S. Army Smart Weapons Management Office
 - » Individual Emerging Systems

SELECTED PRODUCTS SWOE PROGRAM

- 88-1, Program Implementation Plan, USACRREL, Jan 89
- 90-1, One-Dimensional Temperature Modeling Techniques, EG&G Energy Measurements / SPARTA / NASA Goddard Space Flight Center, Aug 90
- 90-8, Representative Weather Data Sets for Hunfeld, Federal Republic of Germany, USAASL, Jul 90
- 90-9, Comparison of Climatologies of Selected SWOE Test Sites, USAASL, Aug 90
- 90-15, Three Dimensional Modelling of Background Scenes at Millimeter Waves, MIT Research Lab. of Electronics, Dec 90
- 92-1, Information Base Procedures for Generation of Synthetic Thermal Scenes, USAEWES, Feb 92
- 92-2, Review of Environmental Research Specific to SWOE for the Battlefield Environment, USACRREL/USATEC/ USAEWES, Jun 92
- 92-6, Data Analysis for Bark and Leaf Reflectance Measurements, Spectral Sciences, Inc./Phillips Lab., Jun 92
- 93-1, A Review of Millimeter Wave Modeling, USACRREL, Mar 93

Prepared by: P. D. Smallidge

IAC SWOE -3

IAC METHODOLOGY

- **DATA BASES**
 - Survey environmental data from military test sites
 - Analyze for
 - » Validity
 - » Range of relevant conditions
- **MODELS**
 - Initial survey of sensor models relevant to smart weapons - IR and MMW
 - Survey and compilation of IR models
 - Workshop to establish / synthesize MMW techniques
- **SIMULATION**
 - Survey government and commercial technologies
 - Evaluate based on smart weapon system drivers / parameters

SUMMARY OF FINDINGS

- **PERFORMANCE OF SMART WEAPONS SYSTEMS HAS BEEN UNPREDICTABLE AND UNRELIABLE FOR EXTRAPOLATION TO THE GLOBAL RANGE OF BATTLEFIELD CONDITIONS.**

- Effects of the environment are treated in generic rather than specific ways.
- There are no environmental criteria for development or testing. The environment is not defined in terms relevant to the performance of smart weapons.
- Environment performance criteria are not keyed to the specific regions within which that system must operate.

- **OPTIONS TO SOLVE THE PROBLEM**

- Real imagery data
- Hybrid imagery
- Synthetic imagery

CONSEQUENCES

- **RECOMMENDED APPROACH:**
 - Validated scene generation process
 - » Integrated physics based models
 - » Terrain and weather data base driver
 - » Workstation environment
 - Compatibility with Distributed Interactive Simulation
- **RESULT:**
 - Smart Weapon Operability Enhancement Joint Test & Evaluation (SWOE JT&E) program initiated in 1992, \$15.2M funding, 3 years
 - Impact: Early consideration of environment in design, optimization of testing, extrapolation of test results

RELEVANCE TO OTHER USERS

- **PHYSICAL SECURITY SYSTEMS**
 - Sensor performance design and evaluation
 - Criteria for logic design to reduce false alarms
- **REMOTE SENSING**
 - Mission planning
 - Image analysis criteria
 - New sensor design / evaluation

Prepared by: P. D. Smallidge

IAC SWOE -7



ARMY NAVY AIR FORCE NASA FAA NATO

CREW SYSTEM ERGONOMICS INFORMATION ANALYSIS CENTER (CSERIAC) PRODUCTS & SERVICES

Presented by

**Donald Dreesbach
AL/CFH/CSERIAC**

**Bldg. 248
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ARMY NAVY AIR FORCE NASA FAA NATO

HUMAN FACTORS IN THE DESIGN OF SYNTHETIC ENVIRONMENTS

- **Task Overview**
- **Project Scope**
- **Subject Matter Addressed**
- **CSERIAC Search & Summary Services**
- **Results of CSERIAC's Efforts**
- **Consequences of CSERIAC's Efforts**
- **Applications**



HUMAN FACTORS IN THE DESIGN OF SYNTHETIC ENVIRONMENTS

- **Definition**
- **Benefits**
- **Components**
- **Goals**
- **Results of CSERIAC's Efforts**
- **Consequences of CSERIAC's Efforts**
- **Applications**



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HUMAN FACTORS IN THE DESIGN OF SYNTHETIC ENVIRONMENTS: TASK OVERVIEW

- **CSERIAC support of the Small Business Innovative Research
Program**
 - » Intelligent Information Presentation for Helmet Mounted Displays in
Synthetic Environments
 - » Force Tactile Feedback for Virtual Reality Environments
 - » Interaction with 3-D "Virtual" Environments



STATE-OF-THE-ART HUMAN FACTORS TECHNICAL INFORMATION: PROJECT SCOPE

- **Exploration of literature to support research for innovative concepts to solve defense-related scientific or engineering problems.**
 - » Explore the presentation of tactical information
 - » Review how humans use tactile feedback in manipulating controls and displays
 - » Investigate how humans interact with 3-D virtual environments



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SUPPORTING INNOVATIVE RESEARCH: SUBJECT MATTER ADDRESSED

- **CSERIAC identified:**
 - Research on the presentation of information for Helmet Mounted Displays
 - » Pilot information load
 - » Information usage
 - » Hardware constraints
 - Literature on force tactile feedback
 - Information for the creation of natural and realistic environments.



CSERIAC SEARCH & SUMMARY SERVICES

- Definition
- Procedure
- Purpose
- Scope



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RESULTS OF CSERIAC's EFFORTS

- Intelligent Information Presentation for Helmet Mounted Displays in Synthetic Environments
- Force Tactile Feedback for Virtual Reality Environments
- Interaction with 3-D "Virtual" Environments





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CONSEQUENCES OF CSERIAC's EFFORTS

- CSERIAC provided a firm basis so small businesses could meet the research needs of the Department of Defense.



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APPLICATIONS

- There are few limitations to the scope of CSERIAC's Research. Although the information is intended for use in aviation settings, the results can be applied to most research and development for synthetic environments.

**TWSTIAC CASUALTY REDUCTION MODELING
FOR THE
NATICK RD&E CENTER**

Prepared by

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**Francis E. Dean, Ph.D.
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Approved for Public Release: Distribution Unlimited

[The final report for this study is Limited Distribution and/or Classified.]

CONTEXT

- DoD S&T THRUSTS 5 AND 6: ADVANCED LAND COMBAT SYNTHETIC ENVIRONMENTS
 - To develop and field land warrior system equipment which improves warrior lethality and survivability
 - DoD S&T Thrust 5: 21st Century Land Warrior (21 CLW) Top Level Demonstration (TLD)
 - Generation II Soldier Advanced Technology Demonstration (ATD)
 - Development of casualty assessment methodologies
 - Development of warrior performance methodologies
 - Development of dismounted warrior distributed
- DoD MILITARY MISSION/FUNCTIONS: GROUND FORCES/INFANTRY SYSTEMS

Prepared by: J. A. O'Keefe-Natick/
F.E. Dean-Battelle/
L. W. Williams-TWSTIAC

TWSTIAC-2

Natick.vu

TWSTIAC TASK/BASIC INFORMATION PRODUCT

TWSTIAC WAS ASKED TO:

- **REVIEW AND COMPARE CASUALTY REDUCTION ANALYSIS METHODOLOGIES**
- **INSTALL NEW MUNITIONS CHARACTERISTICS (ARTILLERY, MORTAR, HAND GRENADE, FLECHETTES, MINES, BOMBS, MISSILES)**
- **DETERMINE THREAT EFFECTS OF MUNITIONS**
- **ASSESS HEAT STRESS AND MOBILITY REDUCTION OF EQUIPMENT**
- **DOCUMENT CASUALTY REDUCTION METHODOLOGY**

Prepared by: J. A. O'Keefe-Natick/
F.E. Dean-Battelle/
L. W. Williams-TWSTIAC

TWSTIAC-3

Natick.vu

TWSTIAC METHODOLOGY

- **METHODOLOGY USED TO PERFORM WORK**
 - **Literature search**
 - **Data analysis**
 - **Data synthesis**
- **APPROACH**
 - **Provided experienced ballisticians**
 - **Created new munition tables for ballistic casualty assessment models**
 - **Developed graphic presentation routines for ballistic casualty assessment models**
 - **Developed metabolic work inputs for integrated soldier and small unit performance simulation**

Prepared by: J. A. O'Keefe-Natick/
F.E. Dean-Battelle/
L. W. Williams-TWSTIAC

TWSTIAC-4

Natick, MA

ASSISTANCE DELIVERED

- **PRE-AND POSTPROCESSORS TO EASE INPUT AND GRAPHICALLY
DISPLAY OUTPUT**
- **METHODOLOGIES REVIEWED AND DOCUMENTED**
- **NEW MUNITION CHARACTERISTICS ADDED TO INPUT DATA
LIBRARIES**
- **LETHAL AREA EFFECTS ANALYZED**
- **HEAT STRESS DUE TO ADDITION OF BODY ARMOR TO MOPP IV
CONFIGURATION ANALYZED**

Prepared by: J. A. O'Keefe-Natick/
F.E. Dean-Battelle/
L. W. Williams-TWSTIAC

TWSTIAC-5

Natick.vu

RESULTS OF DATA ANALYSIS

- **FINDINGS RESULTING FROM THE ANALYSIS OF DATA COLLECTED BY TWSTIAC**

- Additional research is required to correct the underlying methodologies upon which JTCGE-ME ballistic casualty assessment methodologies are based
- Additional research is required to develop a dismounted soldier protocol data unit for DIS

- **SUMMARY OF TECHNICAL RECOMMENDATIONS**

- Additional research to modify the existing ballistic casualty assessment methodologies to allow assessment of non-uniform ballistic protection

Prepared by: J. A. O'Keefe-Natick/
F.E. Dean-Battelle/
L. W. Williams-TWSTIAC

TWSTIAC-6

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CONSEQUENCES

- **WHAT HAS HAPPENED AS A RESULT OF COMPLETION OF TWSTIAC PRODUCTS?**
 - **Financial benefits to DoD**
 - Automated tools to support selection of new materials for ballistic protection
 - Reduced cost for execution of automated tools
 - **Other benefits to DoD**
 - Development of ballistic casualty methodologies for incorporation in integrated soldier simulations
 - Development of metabolic work methodologies for inclusion in DIS Soldier System Simulations

Prepared by: J. A. O'Keefe-Natick/
F.E. Dean-Battelle/
L. W. Williams-TWSTIAC

TWSTIAC-7

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RELEVANCE TO OTHER USERS

- **RELATED OR ANALOGOUS SUBSTANTIVE PROBLEMS FOR WHICH TWSTIAC PRODUCT WOULD BE RELEVANT**
 - **Ballistic casualty assessment models are in use by AMSAA, Dismounted Warfighting Battle Laboratory, and IDA**
- **RELATED OR ANALOGOUS PROBLEMS FOR WHICH THE TWSTIAC PRODUCT WOULD BE RELEVANT BECAUSE OF THE DATA OR METHODOLOGY USED**
 - **Assessment of the combined casualty effects of chemical fragmentation munitions**
 - **Realistic casualty modeling for dismounted individuals in virtual reality and DIS simulations**

Prepared by: J. A. O'Keefe-Natick/
F.E. Dean-Battelle/
L. W. Williams-TWSTIAC

TWSTIAC-8

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COMPUTERS & SOFTWARE COMMUNICATIONS NETWORKING

Prepared by

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Approved for Public Release: Distribution Unlimited

CONTEXT

- **COMPUTERS & SOFTWARE**

- High performance computing systems providing orders of magnitude improvements in Modeling & Simulation

- **COMMUNICATIONS NETWORKING**

- The timely, reliable, and secure production and worldwide dissemination of information using shared communications media and common hardware and application software, organized/managed through established standards and protocols in support of Training, Military Operations, and Research, Development, & Acquisition (RDA)

TWSTIAC PRODUCTS

- **INFORMATION ON ADVANCED APPLICATIONS OF DISTRIBUTED SYSTEMS AND NETWORKING TECHNOLOGY**
 - **Catalog of program applications**
 - **DIS Test Bed**
 - **IEEE DIS Standards & Protocols**
- **DIS EDUCATION / WORKSHOPS**
 - **Standards Workshops**
 - **User Application Workshops**
 - **Computer Generated Forces (CGF) Workshops**

METHODOLOGY

- **VARIETY OF METHODS USED, INCLUDING ...**
 - Survey of key Users / Developers
 - Analysis based on expert panel, peer review, & technical assessments
 - Research on entity representation & alternative networking
- **APPROACH: TRADITIONAL MIXED WITH NEW IDEAS**
 - Applications of DELPHI technique to establish priorities
 - Electronic "Town Meetings" focused on special interest groups
 - Expert seminars organized in conjunction with national conferences; e.g., I/ITSEC, AUSA
 - User workshops geared to change the way Users think and introduce new paradigms for leveraging efforts

SUMMARY OF DATA

- **DATA COLLECTION CATEGORIES**
 - Expert Points of Contact
 - “LESSONS LEARNED” on research findings
 - Key research initiatives sorted by requirements
 - Standards and protocols for networked applications
 - Service and DOD regulatory requirements
 - Key Industry members in the communications field
- **INTERESTING CHARACTERISTICS**
 - Inconsistency in data elements across Users
 - “FEAST OR FAMINE” population of data across areas
 - Lack of configuration control on data
 - Breadth & diversity of Users
 - Volume & quantity of data

RESULTS OF DATA ANALYSIS

- **FINDINGS**

- Condition of networking is of such diversity that linkages can only be accomplished via standard protocols
- Methods of sharing networking solutions are not widely publicized
- Interservice solutions are rare

- **SUMMARY OF TECHNICAL RECOMMENDATIONS**

- Policy on standards in applications must be developed to recognize variety of previous applications
- Standards of data, database design, and horizontal integration are needed to meet the operational needs of Users

SYNTHETIC ENVIRONMENT

Prepared by

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Approved for Public Release: Distribution Unlimited

CONTEXT

- **SYNTHETIC ENVIRONMENT**

- Enhance / mature the synthetic environment to increase its utility for a broader customer base
- Develop “seamless” integration between Virtual, Constructive, and Live modeling & simulation within the Distributed Interactive Simulation (DIS) framework

TWSTIAC PRODUCTS

- **COMPUTER GENERATED FORCES (CGF)**
- **DYNAMIC TERRAIN**
- **HYDROLOGY**
- **ATMOSPHERICS**
- **FIDELITY OF MODELS & TERRAIN**
- **NETWORKING**
- **VIRTUAL REALITY**

Prepared by: Mr. Ernest Smart

TWSTIAC - 2

METHODOLOGY

- **VARIETY OF METHODS USED, INCLUDING ...**
 - **Survey of DIS Users & Developers**
 - **Expert panel, peer review, & technical assessments**
 - **Research on entity representation**
 - **Technical and User workshops**
 - **Electronic "Town Meetings" focused on special interest groups**

SUMMARY OF DATA

- **DATA COLLECTION CATEGORIES**
 - Expert Points of Contact
 - “LESSONS LEARNED” on research findings
 - Key research initiatives leading to new findings to enhance the Synthetic Environment
 - Standards and protocols for networked applications
 - Service and DOD regulatory requirements
 - Technology transfer to Industry and Government
- **INTERESTING CHARACTERISTICS**
 - Complexity of the total concept
 - Lack of configuration control on data
 - Breadth & diversity of Users
 - Interconnectivity of the research areas

RESULTS OF DATA ANALYSIS

• FINDINGS

- Overall lack of knowledge/information within the DIS community**
- General agreement concerning relevance and importance**
- Interservice solutions are rare**

• SUMMARY OF TECHNICAL RECOMMENDATIONS

- Interoperability standards must be developed and maintained to ensure emerging technology and products can be exploited**
- DIS Test Beds must be established and operated to determine levels of system conformance**
- Standards for data, database design, and horizontal integration are needed to meet the operational needs of Users**

TECHNOLOGY FOR AFFORDABILITY

CHEMICAL WARFARE COUNTER PROLIFERATION COMPUTERIZED DECISION AID

Prepared by

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Approved for Public Release: Distribution Unlimited

CONTEXT

- **ARMS CONTROL**
 - **Counter Proliferation**
 - **Chemical Weapons**
 - **Resources and Technologies Necessary to Develop Chemical Weapons**

Prepared by: Dr. Susan Brown, et al

CBIAC - 2

IAC TASK

- **WHY**
 - **Intelligence Analysts Need Tools for Timely Analysis of Potential Chemical Warfare Production Sites**
- **WHAT**
 - **Develop Computerized Decision Aid to Depict Visual Signatures of Chemical Warfare Agent Production Sites based on Technology**
- **WHO**
 - **U.S. Army Foreign Science and Technology Center (A Component of the U.S. Army's Intelligence and Security Command)**

IAC METHODOLOGY

- **USE BASIC CHEMISTRY AND PRODUCTION STANDARDS**
- **BUILD DATABASES**
- **DEVELOP/OBTAIN AND INTEGRATE ANALYSIS AND SPECIAL DESIGN SOFTWARE TO APPLY ENGINEERING STANDARDS AND MANIPULATE DATA**
- **DEVELOP GRAPHICAL USER INTERFACE (GUI) TO DEPICT VISUAL SIGNATURES OF CHEMICAL WARFARE AGENT PRODUCTION SITES**

Prepared by: Dr. Susan Brown, et al

CBIAC - 4

SUMMARY OF DATA

- **CHEMICAL REACTION PROCESS DATA TO INCLUDE**
 - **Reaction Chemistry**
 - **Feedstocks**
- **ENGINEERING PRACTICES AND TECHNOLOGIES OF COUNTRIES OF INTEREST**
 - **Equipment**
 - **Feedstocks (available/unavailable)**
 - **Infrastructure**
 - **Weaponization Capabilities**
- **QUANTITIES OF AGENT PRODUCED**

RESULTS

- **OPERATIONAL PROTOTYPE DEVELOPED AND DEMONSTRATED**
 - **Nerve Agents**
 - **Multi - Country Data**

Prepared by: Dr. Susan Brown, et al

CBIAC - 6



CONSEQUENCES

- **FILLS CRITICAL CAPABILITY VOID**
- **IMPROVES TIMELINESS AND QUALITY OF SITE ASSESSMENTS**
- **PROVIDES CAPABILITY TO EVALUATE ALTERNATE SCENARIOS**
- **PROVIDES CAPABILITY TO ACCOUNT FOR CHANGE IN**
 - **Production Levels**
 - **Technological Capabilities**
 - **Engineering Practices**

OTHER POTENTIAL APPLICATIONS

- **TRAINING AND PREPARATION OF INSPECTION TEAMS**
- **DESIGN ENGINEERS IN CHEMICAL PROCESS INDUSTRY**

Prepared by: Dr. Susan Brown, et al

CBIAC - 8





ARMY NAVY AIR FORCE NASA FAA NATO

CREW SYSTEM ERGONOMICS INFORMATION ANALYSIS CENTER (CSERIAC) PRODUCTS & SERVICES

Presented by

**Donald Dreesbach
AL/CFH/CSERIAC**

Bldg. 248

2255 H Street

Wright-Patterson AFB, OH 45433-7022



ARMY NAVY AIR FORCE NASA FAA NATO

INTEGRATED MAINTENANCE INFORMATION SYSTEM (IMIS): DEFINED

- Human Factors issues in the design of the IMIS -
Portable Maintenance Aid
- IMIS is the maintenance technician's interface with:
 - » Maintenance Information Workstations
 - CAMS (Maintenance Records)
 - SBSS (Supply)
 - CEMS (Engine Monitoring)
 - » Aircraft interface panels



IMPROVED TACTICAL AIRCRAFT MAINTENANCE THROUGH HUMAN FACTORS: IMIS BENEFITS

- **IMIS will improve tactical aircraft maintenance by:**
 - Reducing maintenance downtime
 - Preventing false removals of system components
 - Increasing the productivity of inexperienced technicians
 - Providing more accurate and complete maintenance data



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TECHNICAL INFORMATION AT THE TECHNICIAN'S FINGERTIPS: IMIS COMPONENTS

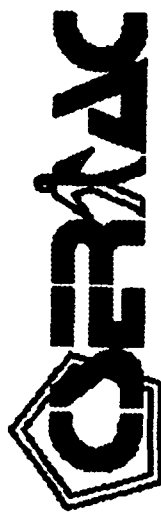
- CSERIAC supported the collection, review, and analysis of human factors technical information for the design of hand-held computers in maintenance environments.
- IMIS provides centralization for maintenance information including:
 - » Technical Orders
 - » Supply and Management Data
 - » Training Data
 - » Aircraft Maintenance Records
 - » Flight Data
 - » Aircraft Diagnostics



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HUMAN COMPUTER INTERACTION ON THE FLIGHTLINE: IMIS GOALS

- **Improved maintenance performance**
- **Develop new concepts and technologies**
 - » Develop new ideas for improving maintenance
 - » Test ideas with few dollars before commitment
 - » Develop enabling technologies
- **Focus on the End-User**
 - » Develop systems from technician's point of view
 - » Conduct field evaluations with maintenance technicians
- **Transition results to system implementors**
 - » Weapon system SPOs (F-22, F-16, JSTARS, C-17, B-2)
 - » Computer-aided acquisition and logistics support (CALS)



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RESULTS OF CSERIAC's EFFORTS

- **Specification for IMIS interface**
 - **Common user interface specification**
 - » Reviewed of Human System Interface issues
 - » Recommended design constraints of the portable maintenance aid
 - **Technical information presentation specification**
 - » MIL-M-87268 general content, style, format, user interaction requirements
 - » Identified user-centered information needs
 - **Lessons Learned as they apply to DoD programs**



ARMY NAVY AIR FORCE NASA FAA NATO

CONSEQUENCES OF CSERIAC's EFFORTS

- CSERIAC's information support permitted timely and accurate:
 - » Specification of:
 - User interface needs
 - IMIS hardware
 - Information content of maintenance tasks
 - Access structures
 - Style and format of information
 - » Identification of:
 - Alternative technologies
 - Human System Interface analysis of requirements for maintenance applications
 - » Development of:
 - Specification/manual
 - Lessons learned document



IMIS APPLICATIONS

- **IMIS will be applied to the maintenance of:**
 - F-22
 - F-16
 - B-2
 - JSTARS
 - Army M-1

- **Technology transfer**



**DATA & ANALYSIS CENTER
FOR SOFTWARE (DACs)**

DACS TECHNICAL REPORTS

Prepared by

**James J. Reed
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Kaman Sciences Corporation
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Approved for Public Release: Distribution Unlimited

DACS TECHNICAL REPORTS

- **THE DACS PRODUCES AND DISTRIBUTES A VARIETY OF SOFTWARE ENGINEERING AND SOFTWARE TECHNOLOGY REPORTS OF INTEREST TO MEMBERS OF THE SOFTWARE ENGINEERING COMMUNITY.**
- **DoD Key Technologies: Computer Software / Computers**
 - o **Software and Systems Engineering**
- **DoD Science & Technology Thrust - 7**
 - o **Technology for Affordability**
- **DoD Military Missions/Functions**
 - o **Technology Transfer**

DACS - 2

Prepared by: James J. Reed

DACS TECHNICAL REPORT TOPIC AREAS

- **SOFTWARE REUSABILITY**
- **DISTRIBUTED DATABASE TECHNOLOGY**
- **ARTIFICIAL NEURAL NETWORKS**
- **SOFTWARE ANALYSIS & TEST TECHNOLOGIES**
- **AN OVERVIEW OF OBJECT ORIENTED DESIGN**
- **SOFTWARE QUALITY**
- **SOFTWARE PROTOTYPING & REQUIREMENTS ENGINEERING**
- **FAST PROTOTYPING OF SOFTWARE - THE SPIRAL MODEL**
- **FORMAL METHODS**
- **NON-ADA TO ADA LANGUAGE CONVERSIONS**

DACS - 3

Prepared by: James J. Reed

TECHNICAL REPORT PREPARATION

- **TOPICS SELECTED BASED ON LEVEL OF INTEREST TO MEMBERS OF THE DACS USER COMMUNITY**

- **TECHNICAL REPORT TYPES**

- **State-of-the-Art Reports**
- **Critical Reviews/Technology Assessments**
- **Data Analysis Reports**
- **Technical Area Task Related Reports**

- **REPORT PRODUCTION**

- **DACS Staff Members**
- **Kaman Sciences Staff**
- **DACS Subcontractor Team**

DACS - 4

Prepared by: James J. Reed

TECHNICAL REPORT SUMMARY

- **SOARs EXAMINE SOFTWARE ENGINEERING TOPICS WHICH INCLUDE LEADING EDGE TECHNOLOGY AND PROVEN TECHNOLOGY OF INTEREST TO OUR USERS**
- **CR/TAs ARE MORE NARROWLY FOCUSED ON A TECHNOLOGY INSTANTIATION**
- **DATA ANALYSIS REPORTS EXAMINE DATA OR ONE OR MORE ASPECTS OF DATA (i.e., SOFTWARE RELIABILITY, etc.)**
- **TECHNICAL AREA TASK RELATED REPORTS DISCUSS ASPECTS OF THE TASK PERFORMED OR SPECIFIC TECHNOLOGIES EXAMINED OR EMPLOYED IN THE TASK**

DACS - 5

Prepared by: James J. Reed

TECHNICAL REPORT RESULTS

- **USER CURRENCY IN THE LATEST SOFTWARE ENGINEERING TECHNOLOGIES, TOOLS, METHODS, AND MEASURES**
- **TECHNOLOGY TRANSITION/TRANSFER**
- **DISCUSSION OF THE TECHNOLOGY TRENDS AND DIRECTIONS**
- **EXPANSION OF DACS STAFF CAPABILITIES INTO THE STATE-OF-THE-ART AND STATE-OF-THE-PRACTICE**
- **TEAM APPROACH TO PRODUCTION ALLOWS US TO OBTAIN REPORTS FROM LEADING SCIENTISTS & ENGINEERS**

DACS - 6

Prepared by: James J. Reed

FUTURE TOPIC AREAS

- **A SURVEY OF SOFTWARE ENGINEERING ENVIRONMENTS**
- **TOOLS FOR SOFTWARE MAINTENANCE**
- **A SUMMARY OF DISTRIBUTED PROCESSING SYSTEMS**
- **A REVIEW OF SOFTWARE MEASUREMENT TOOLS**
- **A MANAGER'S GUIDE TO VERIFICATION & VALIDATION**
- **SOFTWARE DEVELOPMENT RISK MANAGEMENT**
- **ADVANCED ARCHITECTURES FOR DISTRIBUTED SYSTEMS**
- **SOFTWARE PROCESS METRICS AND MEASURES**

DACS - 7

Prepared by: James J. Reed



**DATA & ANALYSIS CENTER
FOR SOFTWARE (DACs)**

**OPEN ARCHITECTURE SYSTEMS FOR
PROCESS AUTOMATION (OASYS)**

Prepared by

**James J. Reed
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Kaman Sciences Corporation
258 Genesee St., Suite 103
Utica, NY 13502**

Approved for Public Release: Distribution Unlimited

OPEN ARCHITECTURE SYSTEMS FOR PROCESS AUTOMATION (OASYS) TOOLSET

- **THE OASYS TOOLSET FOR PROCESS AUTOMATION IS A SUITE OF SOFTWARE TOOLS USED FOR THE RAPID PROTOTYPING AND LOW-COST MAINTENANCE OF WORKFLOW PROCESS SYSTEMS.**

- **DoD Key Technologies: Computer Software / Computers**
 - o **Software and Systems Engineering**
 - o **Human - Computer Interface**
 - o **Software for Parallel & Heterogeneous Distributed Systems**
- **DoD Science & Technology Thrust - 7**
 - o **Technology for Affordability**
- **DoD Military Missions/Functions**
 - o **Technology Transfer**

DACS - 2

Prepared by: James J. Reed

OASYS TOOLSET PROJECT INFORMATION

- **DEVELOPED TO AUTOMATE PRODUCTION OF TECHNICAL DATA PACKAGES FOR WEAPON SYSTEM PROCUREMENT**
- **WORK PACKAGE TRACKING THROUGH DOCUMENT SYSTEMS**
- **MULTI-USER, DISTRIBUTED, HETEROGENEOUS SYSTEMS**
- **OPEN SYSTEM ENVIRONMENT OPERATIONS**
- **ROUTING, PROCESSING & TRACKING OF FORMS & IMAGES**
- **REPLACEMENT FOR HIGH MAINTENANCE SYSTEMS**

- **SPONSOR: US ARMY ARDEC**
PICCATINNY ARSENAL, NJ
AND
USAF ROME LABORATORY
Griffiss AFB, NY 13441

DACS - 3

Prepared by: James J. Reed

OASYS TOOLSET DEVELOPMENT METHODS

- **OASYS TOOLSET METHODOLOGY EMPLOYED**

- **COTS RDBMS And 4GL Application Manager**
- **Object Oriented Design**
- **Client/Server Architecture**

- **PROCESS AUTOMATION APPROACH**

- **Open Systems Environment**
- **Requirements Engineering**
- **Rapid Prototyping**
- **User Training**
- **User Maintained**

DACS - 4

Prepared by: James J. Reed

PROCESS AUTOMATION SYSTEM FEATURES

- **FULL AUDITING OF WORK PACKAGE ACTIONS**
- **FLEXIBLE ROUTING OF FIXED & AD HOC OPTIONS**
- **ELECTRONIC SIGNATURES WITH MULTIPLE SECURITY**
- **FORMS ON PLAIN WHITE BOND WITH SCRIPT SIGNATURES**
- **IMPORT/EXPORT DATA FROM OTHER PLATFORMS**
- **'BUBBLE-UP' MANAGEMENT & EMAIL**
- **PROBLEMS & RESOLUTIONS**
- **PAPERLESS SYSTEM**

DACS - 5

Prepared by: James J. Reed

OASYS TOOLSET RESULTS IN TDP TRACKER

- **TDP TRACKER GOALS**
 - **Link Multiple Users in Distributed System**
 - **Reduce TDP Processing Time From Over 190 to Less Than 60 Days**
 - **Reduce Cost/Improve Quality**
 - **Reduce Paper Volume**
 - **Reduce System Maintenance**
- **TDP TRACKER RESULTS**
 - **> 700 Users at Dover, NJ, Rock Island, IL, and Aberdeen, MD**
 - **Processing Time < 28 Days**
 - **Cost Savings of > \$400,000.00 Per Day**
 - **All Electronic System**
 - **Maintained By One Government Employee**

DACS - 6

Prepared by: James J. Reed

ADDITIONAL APPLICATIONS

- **USA WATERVLIET ARSENAL - ACQUISITION SYSTEM**
- **DTIC - IAC PROGRAM TECHNICAL AREA TASK TRACKER**
- **USA LIFE CYCLE SOFTWARE ENGINEERING CENTER
UPGRADE 10 YEAR OLD ACQUISITION SYSTEM**
- **KAMAN AND OTHER CORPORATE CUSTOMERS IN
MANUFACTURING / PRODUCTION ENVIRONMENTS**
- **ANY GOVERNMENT OR COMMERCIAL PROCESS
AUTOMATION SYSTEM REQUIRING DOCUMENT/DATA
MANAGEMENT**

Prepared by: James J. Reed

DACS - 7

**MTIAC DIRECTORY OF MANUFACTURING
RESEARCH CENTERS**

Prepared by

**Michal Safar
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Chicago, IL 60616**

Approved for Public Release: Distribution Unlimited

MTIAC DIRECTORY OF MANUFACTURING RESEARCH CENTERS DOD THRUST - TECHNOLOGY FOR AFFORDABILITY

- **KEY TECHNOLOGY AREAS AND GOALS**
 - **Product-Process Technology Balance**
 - Demonstrations of scalable production
 - **Concurrent Engineering Capabilities**
 - Invest in Intelligent design tools to facilitate integrated product and process design
 - **Factory Floor Systems**
 - Develop flexible manufacturing systems
 - Develop low-cost, high-precision equipment
 - **Integration Above the Factory Floor**
 - Reduce overhead burdens by half

MTIAC DIRECTORY OF MANUFACTURING RESEARCH CENTERS DOD THRUST - TECHNOLOGY FOR AFFORDABILITY

- **THRUST 7: TECHNOLOGY FOR AFFORDABILITY**
- **MTIAC Mission - Manufacturing Technology**
- **Directory Focus**
 - Assist MTIAC in performing its mission
 - Benefit all MTIAC users
- **Concept Developed with the growth of MTIAC**
 - Routing User Inquiries
 - Improved data access points and analysis
 - Contract requirement accelerated development

MTIAC DIRECTORY OF MANUFACTURING RESEARCH CENTERS DOD THRUST - TECHNOLOGY FOR AFFORDABILITY

- **MTIAC METHODOLOGY**
 - **Data Collection - Identify Centers**
 - **Data Analysis - Organize Common Data Elements**
 - **Data Synthesis - Characterize Centers**
- **APPROACH**
 - **Contact and Communication**
 - **Telephone Interviews vs. mailed surveys**
 - **Organization of Centers**
 - **Identification of common goals, needs**
 - **Workshop**

ARMY STRATEGIC MANTECH PLAN

DOD MISSION - READINESS

- **DATA COLLECTED**
 - **Sector Analyses - Statistical, Analytical and Summary Data**
 - **Composites, Biotechnology, Energetics, Optics, Microelectronics, Chemical Synthesis, Joining, Nondestructive Testing, CAD/CAE, PDES using STEP, Artificial Intelligence, Flexible Manufacturing, Robotics, Environmental**
 - **Workshop - Applications and Problems**
 - **Advanced Materials, Processing and Fabrication, Assembly, Test and Inspection, Planning and Control, Factory Automation, Environmental Issues**
 - **Army Data**
 - **U.S. Army Manufacturing Technology Program Information**
 - **Integrated Industrial Base Strategy**
 - **Strategic Planning of Manufacturing Technologies**
 - **Army Strategic Manufacturing Technology Plan**

MTIAC DIRECTORY OF MANUFACTURING RESEARCH CENTERS DOD THRUST - TECHNOLOGY FOR AFFORDABILITY

- **MANUFACTURING RESEARCH CENTERS - FINDINGS**
 - **Primarily Academic Research Centers**
 - **Government Sponsorship**
 - **Common Goals**
 - **Ignorance of Other Research Centers**
- **RECOMMENDATIONS AND ACTIONS**
 - **Recommended and Held Group Workshop**
 - **Distributed Directory to Participants**

MTIAC DIRECTORY OF MANUFACTURING RESEARCH CENTERS DOD THRUST - TECHNOLOGY FOR AFFORDABILITY

- **DOD AND GOVERNMENT USERS - DIRECT**
 - **Widely distributed**
 - Department of Commerce
 - Institute for Defense Analysis
 - Logistics Management Institute
 - National Institute for Standards and Technology
- **INDIRECT BENEFITS TO DOD AND GOVERNMENT**
 - **Increased Coordination and Efficiency Among Researchers**
 - **Increased Awareness of Ongoing Manufacturing Research**
 - **Problem Identification and Solution**

MTIAC DIRECTORY OF MANUFACTURING RESEARCH CENTERS DOD THRUST - TECHNOLOGY FOR AFFORDABILITY

- **INDUSTRIAL USERS**

- **Widely distributed**

- General Motors
 - United Technology Research Center
 - Institute for Advanced Manufacturing Sciences
 - Research Triangle Institute

- **POTENTIAL USES AND USERS**

- **Research Coordination by Any Organizations Engaged in Manufacturing Research**
 - **Valuable to Anyone Associated with Manufacturing Technologies**

ARMY STRATEGIC MANTECH PLAN WORKSHOP AND MINUTES

Prepared by

**Michal Safar
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Chicago, IL 60616**

Approved for Public Release: Distribution Unlimited

ARMY STRATEGIC MANTECH PLAN

DOD MISSION - READINESS

- **READINESS IN THE BROAD CONTEXT**
 - **Is the Production Base in Place?**
 - Shrinking Defense Industrial Base
 - Increased dependence on foreign suppliers
 - Dwindling surge potential
 - **Are the Technologies Implemented?**
 - Production technologies
 - Leveraging commercial technologies
 - Modernization issues

Prepared by: Michael Safar

MTIAC - 2

ARMY STRATEGIC MANTECH PLAN

DOD MISSION - READINESS

- **MTIAC TASK FOCUS**
 - **Army ManTech Office - 3 Pronged Approach to Readiness**
 - **Technical Assistance - Industrial Sector Analysis**
 - 14 Industrial sectors
 - Summary report and statistics
 - **Industry Input - Workshops**
 - 7 technical areas
 - Joint Army/Industry sessions
 - **Data Organization - Proceedings**
 - Sector analyses
 - Army background material
 - Workshop reports

ARMY STRATEGIC MANTECH PLAN DOD MISSION - READINESS

- **MTIAC METHODOLOGY - SECTOR ANALYSIS**
 - **Collect, Analyze, Synthesize Data**
 - **Succinct Summary with Statistics**
- **MTIAC APPROACH - WORKSHOP AND MINUTES**
 - **Identify and Contact Army Technical Personnel**
 - **Identify and Contact Industrial/Academic Technical Expertise**
 - **Coordinate Both Groups**
 - **Fuse Verbal, Textual, Statistical Information**

Prepared by: Michel Safar

MTIAC - 4

ARMY STRATEGIC MANTECH PLAN

DOD MISSION - READINESS

- **DATA COLLECTED**
 - **Sector Analyses - Statistical, Analytical and Summary Data**
 - Composites, Biotechnology, Energetics, Optics, Microelectronics, Chemical Synthesis, Joining, Nondestructive Testing, CAD/CAE, PDES using STEP, Artificial Intelligence, Flexible Manufacturing, Robotics, Environmental
 - **Workshop - Applications and Problems**
 - Advanced Materials, Processing and Fabrication, Assembly, Test and Inspection, Planning and Control, Factory Automation, Environmental Issues
 - **Army Data**
 - U.S. Army Manufacturing Technology Program Information
 - Integrated Industrial Base Strategy
 - Strategic Planning of Manufacturing Technologies
 - Army Strategic Manufacturing Technology Plan

ARMY STRATEGIC MANTECH PLAN DOD MISSION - READINESS

- **FINDINGS**
 - **Sector Analyses - Statistical, Analytical and Summary Data**
 - Identified Industries driven by DoD vs. commercial sector
 - **Workshop - Applications and Problems**
 - Prioritized list of research problem areas
- **SUMMARY AND RECOMMENDATIONS**
 - **Individual Workshop Recommendations Diverse, Covering Many Technical Issues**
 - **Repeat the Workshops Annually for Ongoing Input**

ARMY STRATEGIC MANTECH PLAN

DOD MISSION - READINESS

- **RESULTS AND BENEFITS**
 - **Improved Planning Capability - Army**
 - **Input to Strategic Mantech Plan**
 - **Increased Awareness by Army Personnel of Industry Issues**
 - **Increased Awareness by Industry of Army Issues**
 - **Benefits of Formal and Informal Technical Networking**

ARMY STRATEGIC MANTECH PLAN

DOD MISSION - READINESS

- **OTHER APPLICATIONS**
 - **Proceedings**
 - Sector Analyses contains technical data relevant to 14 separate Industries
 - Workshop minutes contains specific manufacturing problems and approaches broadly relevant to each topic, not just Army needs
 - **Workshop**
 - Process useful for focussed technical input
 - **Overall Process**
 - Useful in most planning situations

Prepared by: Michal Safer

MTIAC - 8

**RAPID PROTOTYPING
MTIAC STATE-OF-THE-ART-REPORT**

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Approved for Public Release: Distribution Unlimited

MTIAC RAPID PROTOTYPING DOD KEY TECHNOLOGY - DESIGN AUTOMATION

- **DESIGN AUTOMATION COMPONENTS**
 - **Computer-Aided Design**
 - **Concurrent Engineering (Product & Process Development)**
 - **Simulation and Modeling**
- **DESIGN AUTOMATION GOALS AND OBJECTIVES**
 - **Design Tool for Performance, Manufacturability and Life Cycle Issues**
 - **Transportable Product Descriptions**
 - **Functional and Feature Based Design**
 - **High Fidelity Product Visualization**
 - **Product Performance - Supportability Interaction**

MTIAC RAPID PROTOTYPING DOD KEY TECHNOLOGY - DESIGN AUTOMATION

- **KEY TECHNOLOGY - DESIGN AUTOMATION**
 - **Computer-Aided Design**
 - * **Concurrent Engineering (Product & Process Development)**
 - **Simulation and Modeling**

- **APPROACH - EVOLUTIONARY PRODUCT RESPONSE**
 - **1989 - First User Inquiries - First Appearance of Technology**
 - **1990 - Bibliographies - Initial Development**
 - **1991 - Technology Assessment - Technology Explosion**
 - **1993 - State-of-the-Art Report - Technology Established**

MTIAC RAPID PROTOTYPING DOD KEY TECHNOLOGY - DESIGN AUTOMATION

- **MTIAC/IAC METHODOLOGY**
 - **Data Collection - Technical Conferences, Surveys, Literature**
 - **Data Analysis - Standardize System Features**
 - **Data Synthesis - Comparison and Evaluation**

- **APPROACH - TECHNOLOGY TRACKING**
 - **First stage - Identify all material**
 - **Early stage - Organize material, identify issues & trends**
 - **Middle stage - Direct contact with developers and researchers**
 - **Later stage - Track mature technology**

MTIAC RAPID PROTOTYPING DOD KEY TECHNOLOGY - DESIGN AUTOMATION

- **RAPID PROTOTYPING TECHNICAL DATA**

- **Software Requirements (What Do I Need to Implement?)**
 - CAD Data Conversion
 - .STL File Format
- **Systems Information (What Is Available?)**
 - Commercially available
 - Under research
- **Applications Information (Who Has It and Where Can I Get It?)**
 - Industry applications
 - Source Information

MTIAC RAPID PROTOTYPING DOD KEY TECHNOLOGY - DESIGN AUTOMATION

- **FINDINGS**
 - Technology Very New and Developed Quickly
 - Newly Developed Systems Not Well Described or Understood
 - Design Automation Application - Real & Potential
- **RECOMMENDATIONS**
 - Evaluate Software Requirements
 - Evaluate Alternative Prototyping Systems
 - Evaluate Cost Drivers
 - Equipment
 - Software
 - Personnel

Prepared by: Michel Safar

MTIAC - 6

MTIAC RAPID PROTOTYPING DOD KEY TECHNOLOGY - DESIGN AUTOMATION

- **DESIGN AUTOMATION KEY TECHNOLOGY GOALS**
 - High fidelity product visualization
 - Product and Process Definition
 - o Physical Implementation Prototyping
- **TECHNOLOGY FOR AFFORDABILITY**
 - Reduction in Time to Market
 - Early Detection of Design Flaws
 - Cost Reduction
- **MTIAC PRODUCT BENEFITS**
 - Evaluation Tool Available
 - Increased Technology Implementation

MTIAC RAPID PROTOTYPING DOD KEY TECHNOLOGY - DESIGN AUTOMATION

- **BROAD AUDIENCE**
 - Evolutionary Product Development
 - Ongoing User/Producer Input
- **TECHNICAL APPLICATIONS EVALUATIONS**
 - Standardized Evaluation Criteria
 - Software requirements
 - Equipment requirements
 - Other considerations
 - Standardized Data Presentation
 - Comparison charts
 - Standardized data sheets

NTIAC

**NONDESTRUCTIVE/NON-INTRUSIVE
SENSORS FOR MANUFACTURING
PROCESS CONTROL**

Prepared by

**Gary W. Carriveau
NTIAC
415 Crystal Creek Drive
Austin, Tx. 78746**

Approved for Public Release: Distribution Unlimited

Prepared by: Gary W. Carriveau

NTIAC - 1

CONTEXT

- **NONDESTRUCTIVE EVALUATION AND INSPECTION OF MATERIALS AND SYSTEMS HAS BEEN IDENTIFIED AS A DOD CRITICAL TECHNOLOGY**
 - The objective of this task is to investigate the application of nondestructive/non-intrusive sensors for manufacturing and material process control. This includes sensors used in monitoring the process result (product) and the state-of-health of the fabrication equipment used to produce the product.

Prepared by: Gary W. Cariveau

NTIAC - 2

NTIAC TASK FOCUS

- **NONDESTRUCTIVE AND NON-INTRUSIVE SENSORS AND "SMART" SENSOR SYSTEMS ARE URGENTLY NEEDED FOR IN-PROCESS CONTROL OF MANUFACTURING LINES, REAL-TIME CONTROL OF MATERIAL PROCESSING, AND IN-SITU MONITORING OF THE CONDITION AND PERFORMANCE OF PROCESSING EQUIPMENT**

- **APPLICATION OF THESE SENSOR SYSTEMS WILL RESULT IN INCREASED PRODUCTIVITY, REDUCED MATERIAL WASTE, REDUCED EQUIPMENT DOWN TIME, AND IMPROVED EQUIPMENT MAINTENANCE PROCEDURES**

- **NTIAC was requested by the Army Research Laboratory, Materials Directorate, Material Evaluation Branch to investigate the use of NDE sensors for advanced manufacturing in support of the Manufacturing Technology Program**
- **Assistance is to be provided in the form of a technology assessment, the results are to be used in strategic planning**

NTIAC METHODOLOGY

- **BIBLIOGRAPHIC SEARCH**
- **SITE VISITS TO ASSESS CURRENT TECHNOLOGY**
- **DEFINITION OF APPLICABLE TECHNOLOGIES**
- **IDENTIFICATION OF TECHNOLOGY GAPS**
- **ASSISTANCE IN COORDINATION OF EFFORTS BY DOD, OTHER GOVERNMENT, ACADEMIA AND INDUSTRY**

Prepared by: Gary W. Carriveau

NTIAC - 4

0.1718

SUMMARY OF DATA

- **BIBLIOGRAPHIC SEARCH**
- **ANALYSIS AND SYNTHESIS OF CITED DATA**
- **SITE VISITS**
- **WORKSHOPS/CONFERENCES**

Prepared by: Gary W. Cariveau

NTIAC - 5

ANALYSIS RESULTS

- **FINAL TECHNICAL REPORT IN THE FORM OF A TECHNOLOGY ASSESSMENT**
- **REQUIREMENTS ANALYSIS FOR NDE SENSORS USED IN MANUFACTURING**
- **IDENTIFICATION OF POTENTIAL APPLICABLE SENSOR TECHNOLOGIES**
- **IDENTIFICATION AND DEFINITION OF SENSOR TECHNOLOGY GAPS**

Prepared by: Gary W. Carriveau

NTIAC - 6

EXPECTED RESULTS AT THE CONCLUSION OF THIS EFFORT

- **INPUT FOR MANUFACTURING TECHNOLOGY STRATEGIC PLANNING**
- **DEFINITION OF NDE SENSOR REQUIREMENTS FOR MANUFACTURING**
- **REQUIREMENT ANALYSIS AND RECOMMENDED SUPPORT FOR SENSORS TO FILL TECHNOLOGY GAP**
- **PROFESSIONAL CONFERENCE PRESENTATION/PUBLICATION**
- **ASSISTANCE IN ORGANIZING AN INTERNATIONAL MEETING ON MECHANICAL FAILURE PREVENTION**

RELEVANCE TO OTHER USERS

- THE RESULTS WILL BE USEFUL TO ANYONE INVOLVED IN MANUFACTURING PROCESSES
- APPLICATIONS WILL IMPROVE PRODUCTIVITY AND REDUCE MATERIAL AND OPERATING COSTS
- PROVIDES ADDITIONAL INFORMATION FOR NDE SENSOR DEVELOPMENT

CONCURRENT ENGINEERING SERIES

**(DoD S&T THRUST: TECHNOLOGY FOR
AFFORDABILITY)**

Prepared By

**Preston R. MacDiarmid
Director
Reliability Analysis Center
201 Mill Street
Rome, NY 13440-6916**

Approved for Public Release: Distribution Unlimited

RAC PRODUCT STRATEGY

- **TARGET MANAGERS**

- **Awareness**
- **Impact on programs**
- **Basics**
 - o **Terminology**
 - o **Tasks**
 - o **Subtasks**
- .
- .
- .

- **TARGET DESIGNERS**

- **Impact of new technologies**
- **Design practices/guidelines**
- **Ability to trade-off alternatives**

- **TARGET R/M/Q PRACTITIONERS**

- **Procedural guides**
- **Data to support analyses**
- **Quick guides/automated tools**

PRODUCT RELEVANCE

- **DOD S&T THRUST: TECHNOLOGY FOR AFFORDABILITY**
- **PRODUCT FOCUS**
 - **Stresses concurrent engineering impacts on R&M**
 - **Leverage automation of R&M techniques**
 - **Products to date:**
 - o **Introduction to CE**
 - o **Failure Mode Effect and Criticality Analysis**
 - o **Fault Tree Analysis**
 - o **Worst Case Circuit Analysis**
 - o **Reliability/Maintainability Software Tools**
- **PRODUCT IMPACT**
 - **Make application of R&M technologies more cost effective in CE process with end result lower life-cycle cost**

"RELIABILITY/MAINTAINABILITY SOFTWARE TOOLS (RMST-93)" SAMPLE RECORD

Name: RPP (Reliability Prediction Program)

Description:

Implementation of part stress reliability prediction MIL-HDBK-217 for systems limited in size only by disk storage space. Standard features include: provisions for system structure input and editing, component data input and editing, access to part data libraries, defaults for component reliability calculations, part/assembly/system failure rate calculation, generation of twelve predefined reports on part/ assembly/ system, utilities for file and computer system management.

Hard/Software Req.: IBM PC, UNIX, Macintosh, NeXT, Sun SPARC Workstations

Interface Capabilities: Powertronic's MPP, FME, and SRP

**Supplier: Powertronic Systems, Inc.
13700 Chef Menteur Hwy.
New Orleans, LA 70129**

Demo Avail. & Price: Free

Phone: (504) 254-0383

Software Price: \$ 1,700

'RELIABILITY/MAINTAINABILITY SOFTWARE TOOLS (RMST-93)" SAMPLE TABLE

Product Name	IBM PC	VAX	UNIX	Mac	Apollo	Sun	Other	Page #
217 Predicts				X				13
ARM E (Advanced Reliability Modeling)	X	X	X					13
ARM F (Advanced Reliability Modeling)	X	X	X					13
Bellcore ARPP	X	X	X					21
Belstress	X	X						21
Computer Aided Reliability Program (CARP)	X							13,19
DORMACALC 4.0	X							25
FNPRD-3 (Nonelectronic Parts Reliability Data)	X							21
Hardstress	X	X						21
MDR-21A Data	X							22
MECHREL (Mechanical Reliability Prediction Program)	X							27
MRP (Mechanical Reliability Prediction Program)	X							27
Milstress	X	X						14
PC COMMERCIAL	X		X					22
PC MIL-HDBK-217F	X							14
PC STRESS Analysis	X							14
PREL	X							22

CURRENT RAC PRODUCTS

DATA PUBLICATIONS	6
APPLICATION GUIDES	11
COMPONENT PUBLICATIONS	7
SPECIALIZED SERIES:	
-- Concurrent Engineering	5 *
-- Reliable Applications of Components	3
-- Total Quality Management Series	3
SOFTWARE/DATABASES	<u>7</u>
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TOTAL QUALITY MANAGEMENT (TQM) TOOLKIT

(DoD S&T THRUST: TECHNOLOGY FOR AFFORDABILITY)

Prepared By

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Rome, NY 13440-6916**

Approved for Public Release: Distribution Unlimited

RAC PRODUCT STRATEGY

- **TARGET MANAGERS**

- **Awareness**
- **Impact on programs**
- **Basics**
 - o **Terminology**
 - o **Tasks**
 - o **Subtasks**
 - .
 - .
 - .

- **TARGET DESIGNERS**

- **Impact of new technologies**
- **Design practices/guidelines**
- **Ability to trade-off alternatives**

- **TARGET R/M/Q PRACTITIONERS**

- **Procedural guides**
- **Data to support analyses**
- **Quick guides/automated tools**

PRODUCT RELEVANCE

- **DOD S&T THRUST: TECHNOLOGY FOR AFFORDABILITY**

- **PRODUCT FOCUS**

- Continuous improvement
- Variability reduction

- **PRODUCT IMPACT**

- Higher quality
- Reduced cost

Ordering No.: SOAR-4

State-of-the-Art Report Process Action Team Handbook

Prepared by

Reliability Analysis Center
PO Box 4700
Rome, NY 13445-4700

Under contract to

Rome Laboratory
Office AFRL, NY 13445-4700

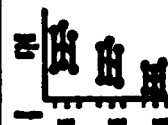
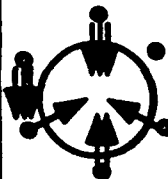
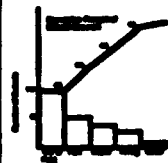
Total Quality Management Toolkit

An encyclopedic
listing of
TQM Tools

RAC

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Rome, NY 13445-4700

RAC is a DoD Information Analysis Center sponsored by the
Defense Technical Information Agency



Reliability Analysis Center

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Rome, NY 13445-4700

State-of-the-Art Report

A GUIDE FOR IMPLEMENTING TOTAL QUALITY MANAGEMENT

RAC

Reliability Analysis Center
A DoD Information Analysis Center

TQM TOOLKIT TOPICS

SEVEN BASIC TOOLS	SEVEN MANAGEMENT TOOLS	OTHER TOOLS
<p>Flow Charts</p> <p>Ishikawa Diagrams</p> <p>Checklists</p> <p>Pareto Charts</p> <p>Histograms</p> <p>Scattergrams</p> <p>Control Charts</p>	<p>The Affinity Diagram</p> <p>The Relations Diagram</p> <p>The Tree Diagram</p> <p>Matrix Analysis</p> <p>QFD</p> <p>Process Decision Program Chart</p> <p>The Arrow Diagram</p>	<p>The Force Field</p> <p>The Measles Chart</p> <p>Benchmarking</p> <p>Cycle Time Management</p> <p>Multi-Var Charts</p> <p>The Five-Why's</p> <p>Design of Experiments</p> <p>Action Plans</p>

CURRENT RAC PRODUCTS

DATA PUBLICATIONS 6

APPLICATION GUIDES 11

COMPONENT PUBLICATIONS 7

SPECIALIZED SERIES:

-- **Concurrent Engineering** 5

-- **Reliable Applications of Components** 3

-- **Total Quality Management Series** 3 *

SOFTWARE/DATABASES 7

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COMPUTER-BASED AIRCRAFT WIRING MAINTENANCE AID

Prepared by

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Approved for Public Release: Distribution Unlimited

CONTEXT

- **APPLY KEY DOD COMPUTER AND SOFTWARE TECHNOLOGIES TO SUPPORT AIR FORCE TACTICAL LAND-BASED FORCES FOR AIR SUPERIORITY AND PRECISION STRIKE:**
 - **To Develop Computer-Based Wiring Damage Assessor's Aid that Would Allow Maintenance Technicians Capability to Rapidly Access Wiring Data**
 - **To be Compatible with DoD Integrated Maintenance Information System (IMIS) Program**
 - **To Keep Data Current for Fielded System**
 - **To Investigate Feasibility of Using Wiring Data in Conjunction with Aircraft Self-Diagnostic Capability**

COMPUTER-BASED AIRCRAFT WIRING MAINTENANCE AID

- **KEY TECHNOLOGY**
 - **Computers, Software**
- **SURVIAC TASK FOCUS**
 - **Support the Air Force Aircraft Battle Damage Repair (ABDR) Advanced Development Technology Program (ADTP) Office**
 - **Develop/Enhance a Computerized Aircraft Maintenance Aid for Assessing Wiring Damage to Aircraft**
 - **High Performance Computing System Providing Improvements in Maintenance Capabilities**
 - **Assist in the Development of Graphics Capability and Support for Deployment for Desert Shield**

SURVIAC METHODOLOGY

- **METHODOLOGY USED TO PERFORM WORK**
 - **Conduct Feasibility Study**
 - **Develop Prototype**
 - **Field-Test Prototype**
 - **Enhance Prototype Based on User Comments**
 - **Transition to Field**
- **APPROACH**
 - **Utilized Off-The-Shelf Computer Hardware/Software**
 - **Used Existing Manufacturer Wiring Data**
 - **Developed Data on Pass-Through Wires and Access Door Location**

SUMMARY OF DATA

- **DATA COLLECTED**
 - **Obtained Detailed Wiring Routing and Characteristics Data**
 - **Obtained Installation Drawings for the Specific Aircraft**
 - **Collected Numerous Suggestions from Operators on How to Improve/Enhance Prototype**
- **DATA CHARACTERISTICS**
 - **Database is Transparent to the User**
 - **User Interface Allows Quick Retrieval and Display of the Data**
 - **No Special Training Necessary; User Interface Leads the User Step by Step**

RESULTS OF DATA ANALYSIS

- **FINDINGS SYNTHESIZED BY SURVIAC**
 - **Computerized Wiring Maintenance Aid is Feasible**
 - **Field-Testing of Prototype Demonstrated that Such a Tool can Reduce Time to Repair Aircraft Wiring**
 - **Computerized Tool can be Utilized by Individuals Who have not had Electrical Training**
- **SUMMARY OF TECHNICAL RECOMMENDATIONS**
 - **Automate Aircraft Wiring Data for Expeditionary Repair of Damaged Wiring**
 - **Explore Transfer of Concept to Other DoD Aircraft, Commercial Aircraft, and Other Vehicles**

CONSEQUENCES

- **WHAT HAS HAPPENED AS A RESULT OF COMPLETION OF THIS SURVIAC PRODUCT**
 - **Financial Benefits to DoD**
 - Reduced Time for Aircraft Wiring Repair, Hence Financial Savings
 - Less Experienced Individuals Perform at Higher Levels of Expertise
 - **Other Benefits to DoD**
 - Reduced Time to Repair Battle Damaged Aircraft Results in Improved Combat Effectiveness
 - **Changes in DoD Operations, Plans, or Procedures as a Direct Result of Product**
 - Wiring Maintenance Procedures will be Improved

RELEVANCE TO OTHER USERS

- **OTHER AIRCRAFT SYSTEMS**
 - **Hydraulics**
 - **Fuel**
 - **Environmental Control System**
- **OTHER DOD AIRCRAFT**
- **COMMERCIAL AIRLINERS**
- **SEA SYSTEMS**
- **LAND SYSTEMS**
- **BUILDINGS**
- **AUTOMOBILES**